AD-A059 795 UNITED TECHNOLOGIES CORP WINDSOR LOCKS CONN HAMILTON --ETC F/G 1/3
DISASSEMBLY INSPECTION AND OVERHAUL OF X-22A GEAR REDUCTION AND--ETC(U)
JUL 78 E H WALZ N62269-77-C-0035

UNCLASSIFIED NADC-76220-60 NL

1 OF 2
AD A059795

REPORT NADC 76220-60

DISASSEMBLY INSPECTION AND OVERHAUL

OF

X-22A GEAR REDUCTION AND PROPELLER ASSEMBLIES

HAMILTON STANDARD
DIVISION OF UNITED TECHNOLOGIES CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

JULY 1978

FINAL REPORT FOR PERIOD MAY 1977 - JULY 1978
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Prepared for:

NAVAL AIR DEVELOPMENT CENTER

WARMINISTER, PA. 18974

(18) (19)
REPORT NADC 76229-60

(6) DISASSEMBLY INSPECTION AND OVERHAUL

OF

X-22A GEAR REDUCTION AND PROPELLER ASSEMBLIES.

(9) Final rept. May 77 - Jul 78,

(10) E. H. Walz

HAMILTON STANDARD
DIVISION OF UNITED TECHNOLOGIES CORPORATION
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(15) N62269-77-C-0035

(16) F41421 (17) WF41421291

(11) JULY 1978 (12) 194 P.

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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7. AUTHOR(s) E.H. Walz		8. CONTRACT OR GRANT NUMBER(s) N62269-77-C-0035
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16. DISTRIBUTION STATEMENT *(of this Report)*

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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Shrouded Propeller	Disassembly
Turboprop	Inspection
Gear Transmission	Overhaul

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report presents the results of the disassembly inspection and overhaul of four Hamilton Standard designed and fabricated X-22A gear reduction and propeller assemblies. These units had operated intermittently since 1966 and had accumulated a total of 574 flight research hours. All functional components appeared to be in satisfactory condition and, following minor corrective action, the units were returned to service.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

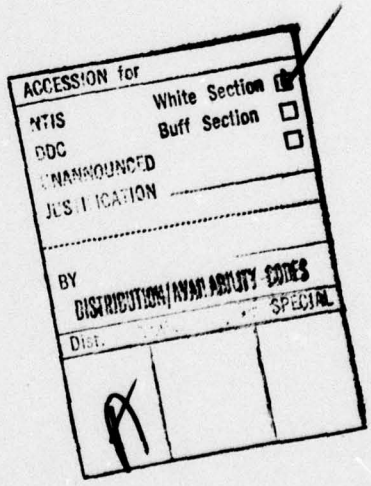
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

PREFACE

This report concludes a fourteen month program involving the disassembly inspection and overhaul of four Hamilton Standard X-22A Gear Reduction and Propeller assemblies, P/N's 131GB8-3 and 131GB9-4. The program was conducted by Hamilton Standard for the Naval Air Development Center (NADC) under Contract N62269-77-C-0035 and was an outgrowth of the experience gained in the performance of NAVAIR contract N00019-75-C-0199 which had been previously completed.

Naval Air Development Center technical direction was provided by the Contracting Officer's Technical Representative, Mr. John Clark, of the Aircraft and Crew Systems Technology Directorate.

This program was conducted under the management of D. J. Nelson, Program Manager, and directed by E. H. Walz, Assistant Project Engineer.



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INTRODUCTION

The Bell Aerospace Company (BAC) developed the X-22A aircraft for the Naval Air Systems Command (NASC) in the early 1960's under contract Now63-0118-ci. The aircraft is powered by four T58 turbine engines and four 84 inch diameter, three way, fiberglass blade, ducted propellers designed and built by the Hamilton Standard Division (HS) of United Technologies Corporation.

Two aircraft and twelve Gear Reduction and Propeller assemblies, for support of these aircraft, were manufactured. Four, one ship set, of the Gear Reduction and Propeller assemblies were removed from service in 1966 following a hard landing which caused major damage to the number one aircraft, serial number BuNo151520, and some minor Gear Reduction and Propeller distress. A second ship set was removed from the number two aircraft, serial number BuNo151521, in 1974 after having reached the 200 hour-time-between-overhaul limit. These eight Gear Reduction and Propeller assemblies were returned to HS under contract N62269-77-C-0035 for inspection and overhaul.

DISCUSSION

Background

In 1970, following a seven year development effort with BAC, the NASC awarded Calspan Corporation, Buffalo, New York, the first in a continuing series of flight research contracts. On 26 May 1977 four HS Part Number (P/N) 131GB8-1 and four 131GB9-2 Gear Reduction and Propeller assemblies were returned to HS by Calspan for inspection and overhaul. The operational record, as documented by the individual Aeronautical Equipment Service Record, for each of the eight assemblies is shown below in Table 1.

TABLE 1 OPERATIONAL RECORD

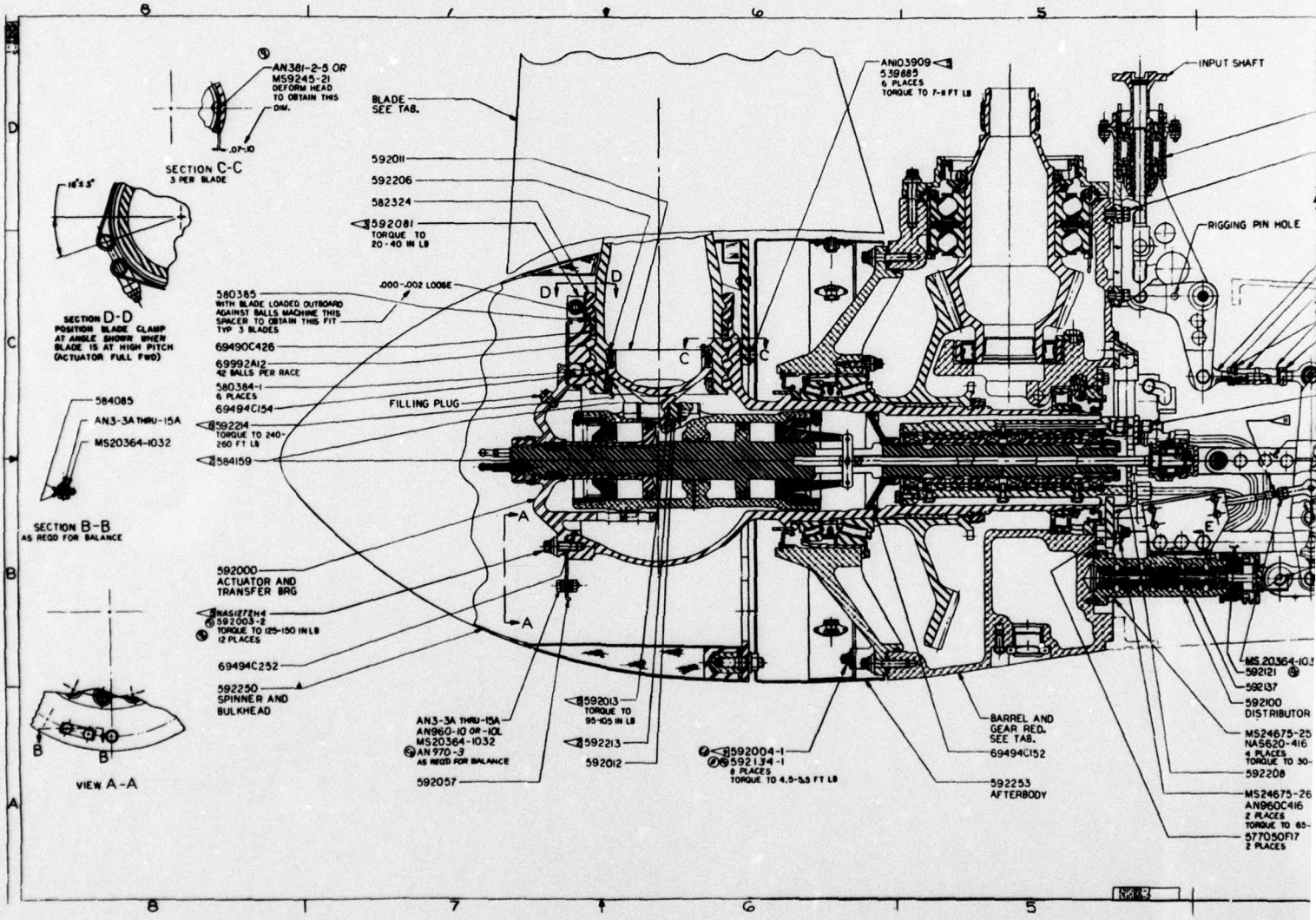
Part Number	Part Name	Serial Number	Aircraft Position	Aircraft Serial Number	Time Since Overhaul (hours)	Total Time (hours)
131GB9-2	Gear Reduction and Propeller Assembly, L.H.	222416	1	151521	209.4	405.7
		222417	2	151521	201.1	201.1
		222418	1	151520	New	35.8
		222419	2	151520	New	59.3
131GB8-1	Gear Reduction and Propeller Assembly, L.H.	222414	3	151521	211.2	300.9
		222410	4	151521	194.2	402.4
		222412	3	151520	New	35.8
		222411	4	151520	New	35.8

The original requirement of this program, as initiated on 27 May 1977, was to externally inspect eight assemblies and then following a selection process, disassemble and inspect one ship set; i.e., two each of P/N's 131GB8-1 and 131GB9-2. Then, as dictated by the inspection results, overhaul the selected ship set of assemblies. However, on 29 September 1977, NADC redirected the program to update the selected assemblies by reconfiguring the signal converter subassemblies from P/N's 592008-1 (used on 131GB8-1) and 592008-2 (used on 131GB9-2) to 726600-1 and 726600-2. The P/N 726600 type of Converter is part of the aircraft Feedforward Flight Control System and provides for improved control, with vernier precision, in positioning the actuators for propeller pitch and aircraft elevon angle. The reconfiguring action caused the end assemblies to be reidentified as 131GB8-3 and 131GB9-4, respectively. Table 2 presents the major differences between dash number 1, 2, 3 and 4 end assemblies.

TABLE 2. PARTS LISTS

Assembly Number	Assembly Name	Gear Reduction and Propeller Assembly 131GB8-1	131GB8-3	131GB9-2	131GB9-4
592000	Actuator and Transfer Bearing	1	1	1	1
592001	Barrel and Gear Reduction - R.H.	1	1	0	0
592002	Barrel and Gear Reduction - L.H.	0	0	1	1
1FA7A3-0A	Blade - R.H.	3	3	0	0
1FA7A4-0A	Blade - L.H.	0	0	3	3
592100	Distributor Valve	1	1	1	1
592250	Spinner and Bulkhead	1	1	1	1
592253	Afterbody	1	1	1	1
592008-1	Converter - R.H.	1	0	0	0
592008-2	Converter - L.H.	0	0	1	0
726600-1	Converter - R.H.	0	1	0	0
726600-2	Converter - L.H.	0	0	0	1

Figures 1 through 10 are drawings of each of the above assemblies.



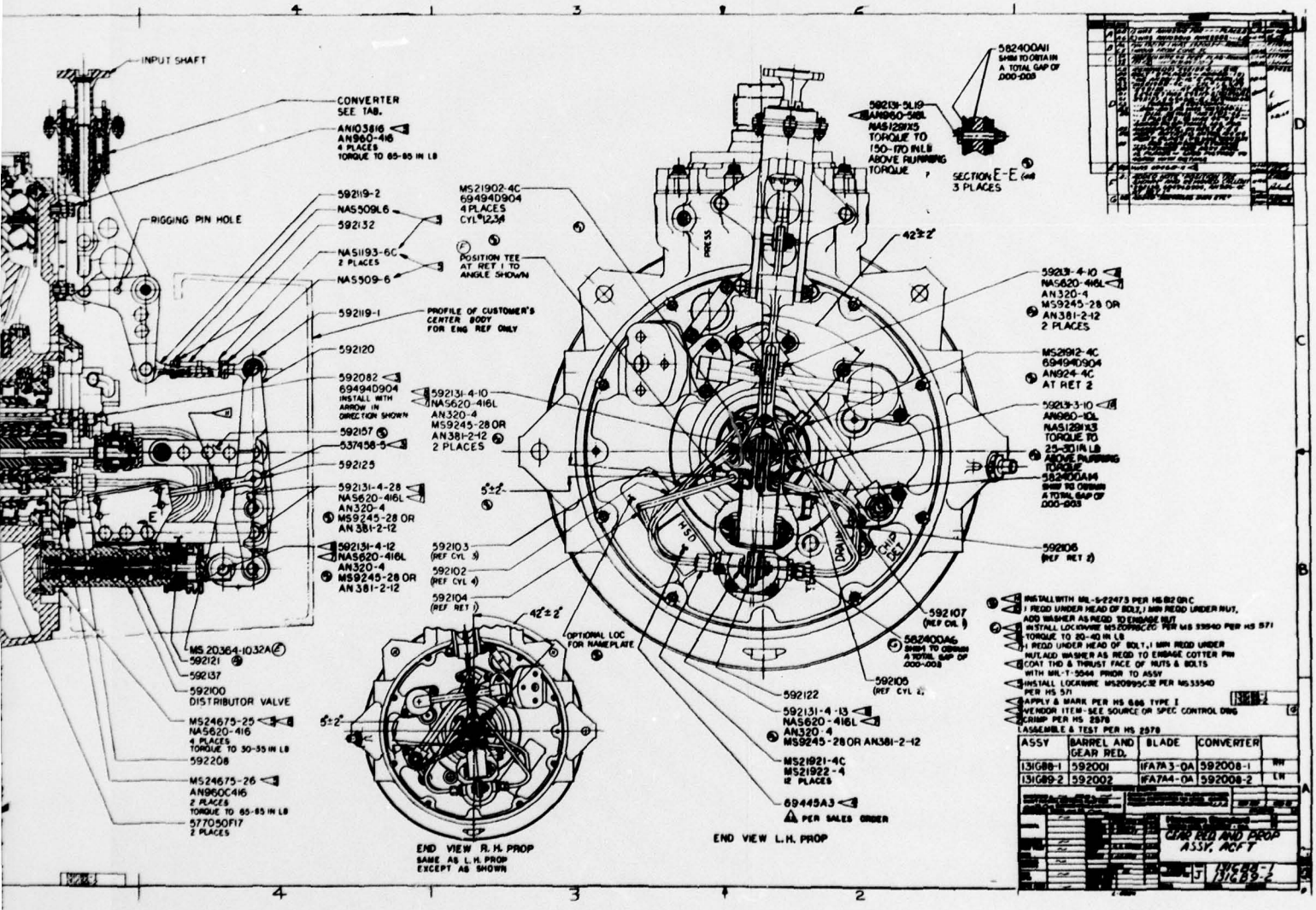


Figure 1.

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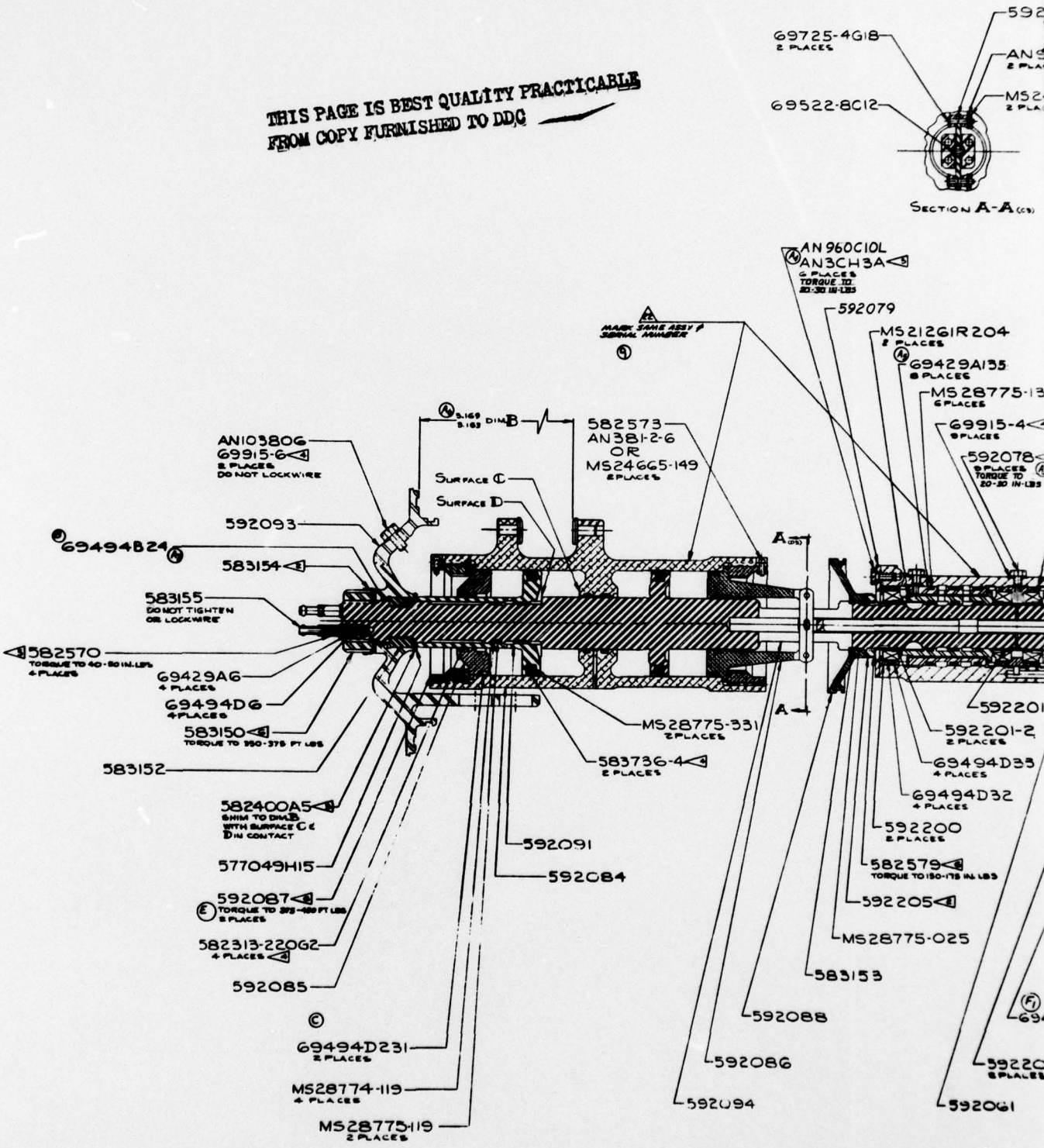

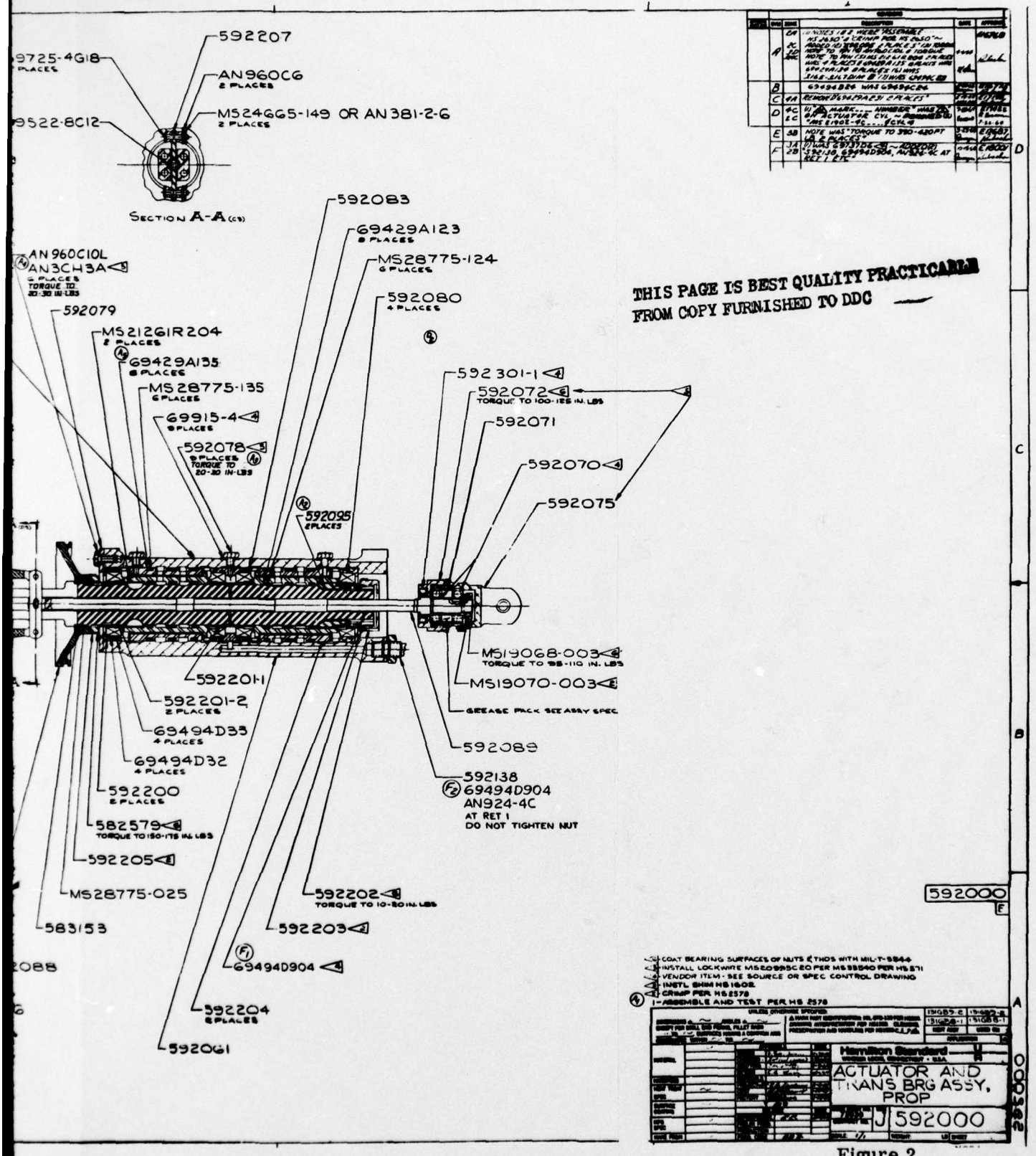

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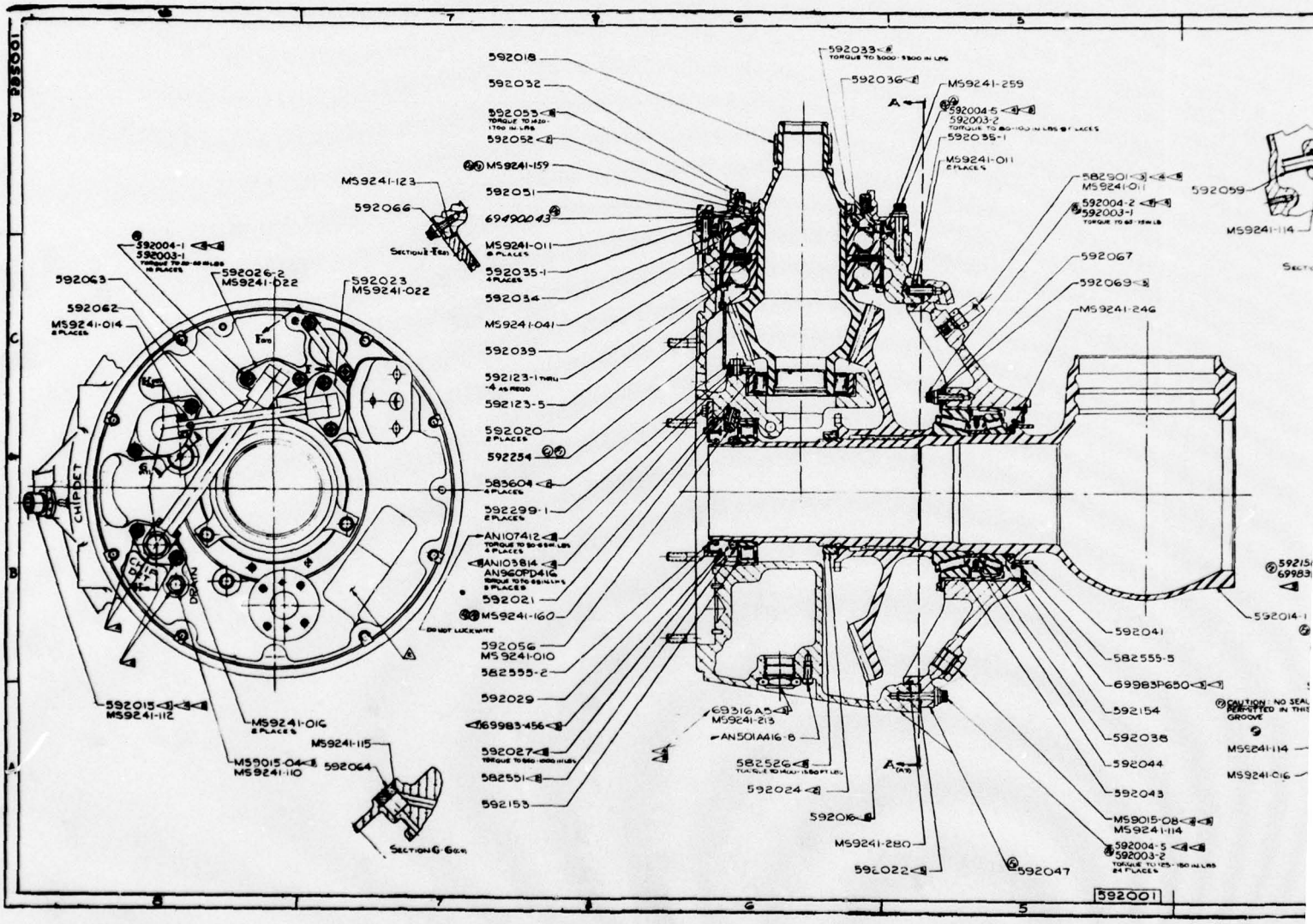

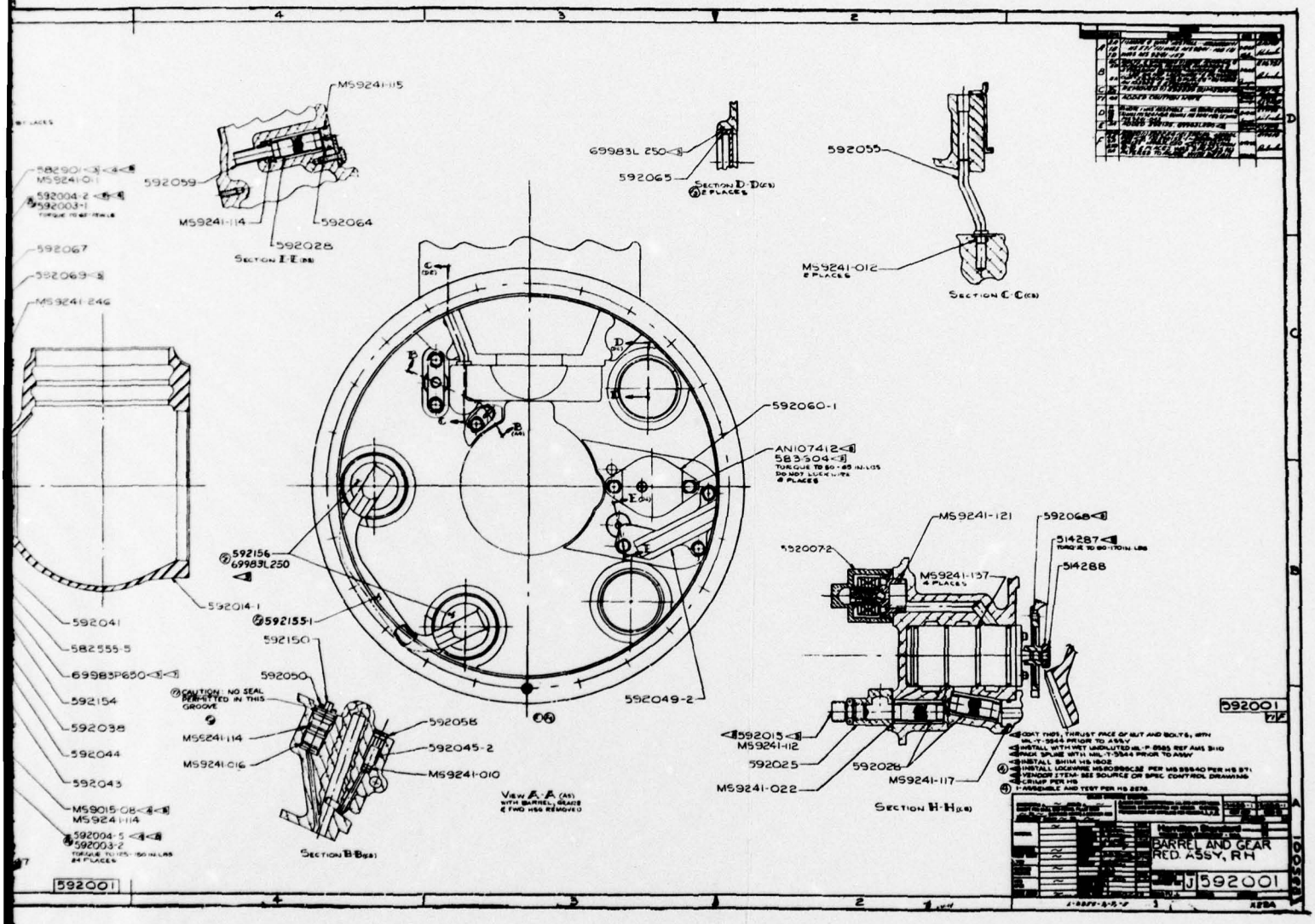

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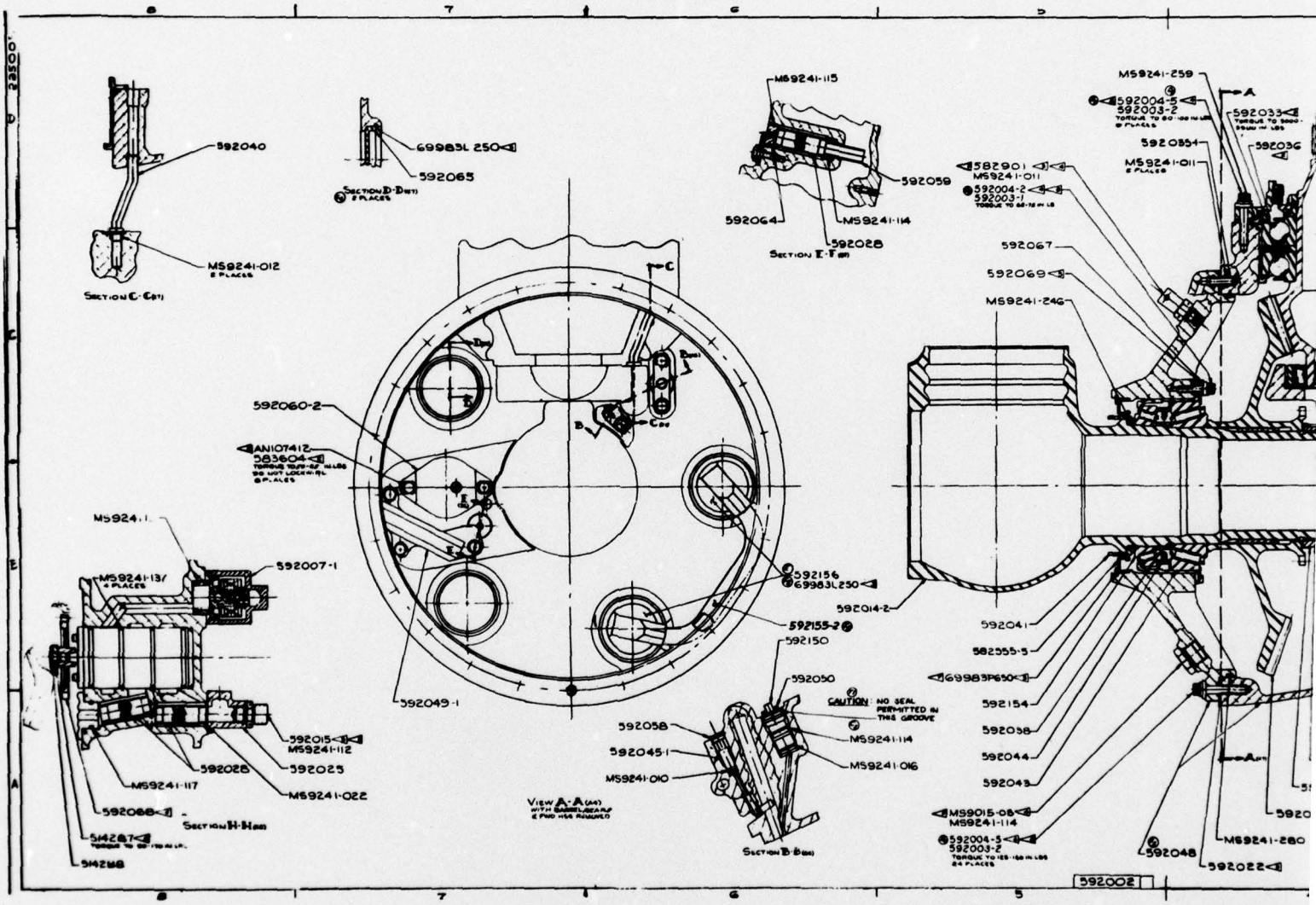

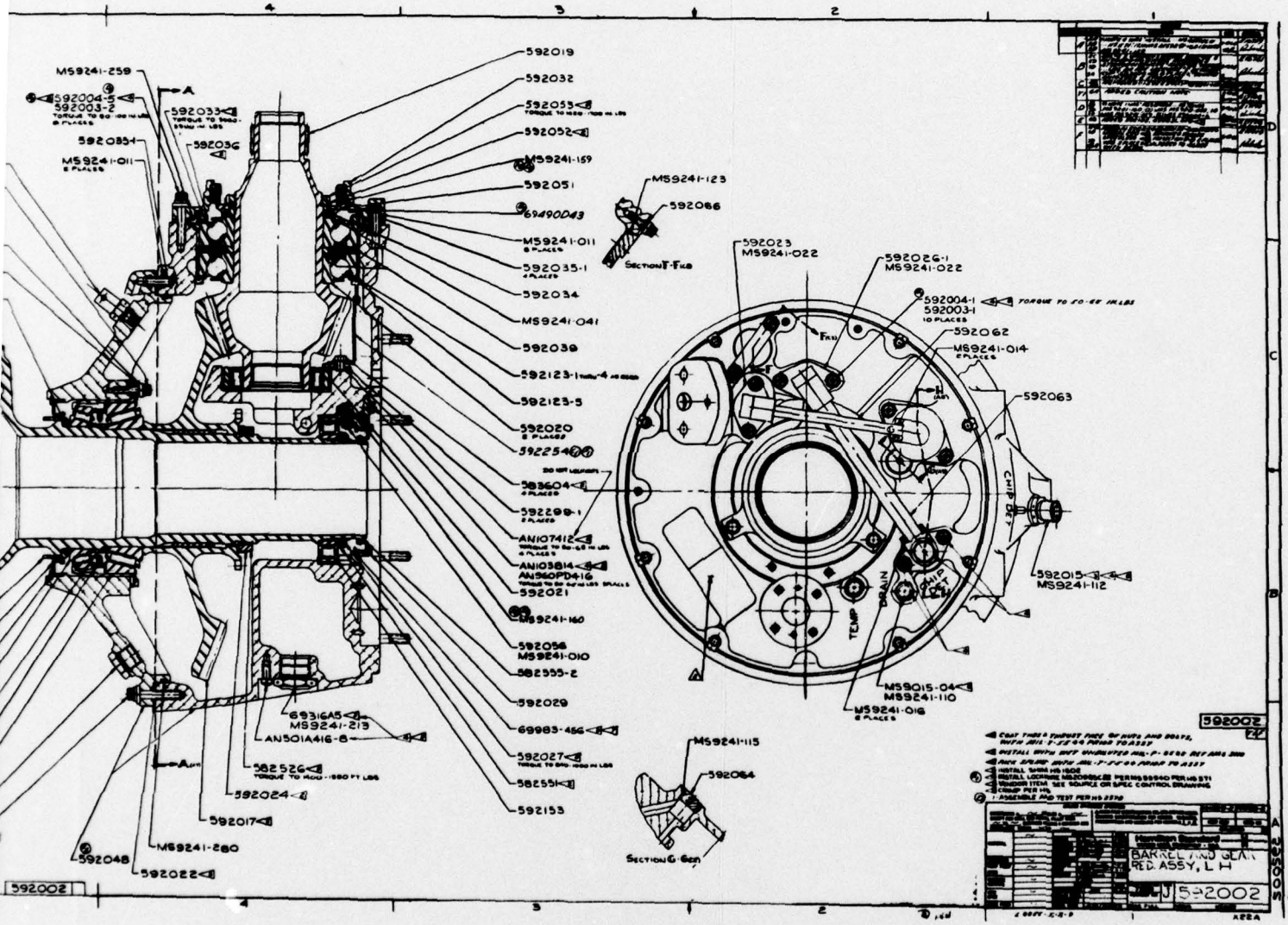

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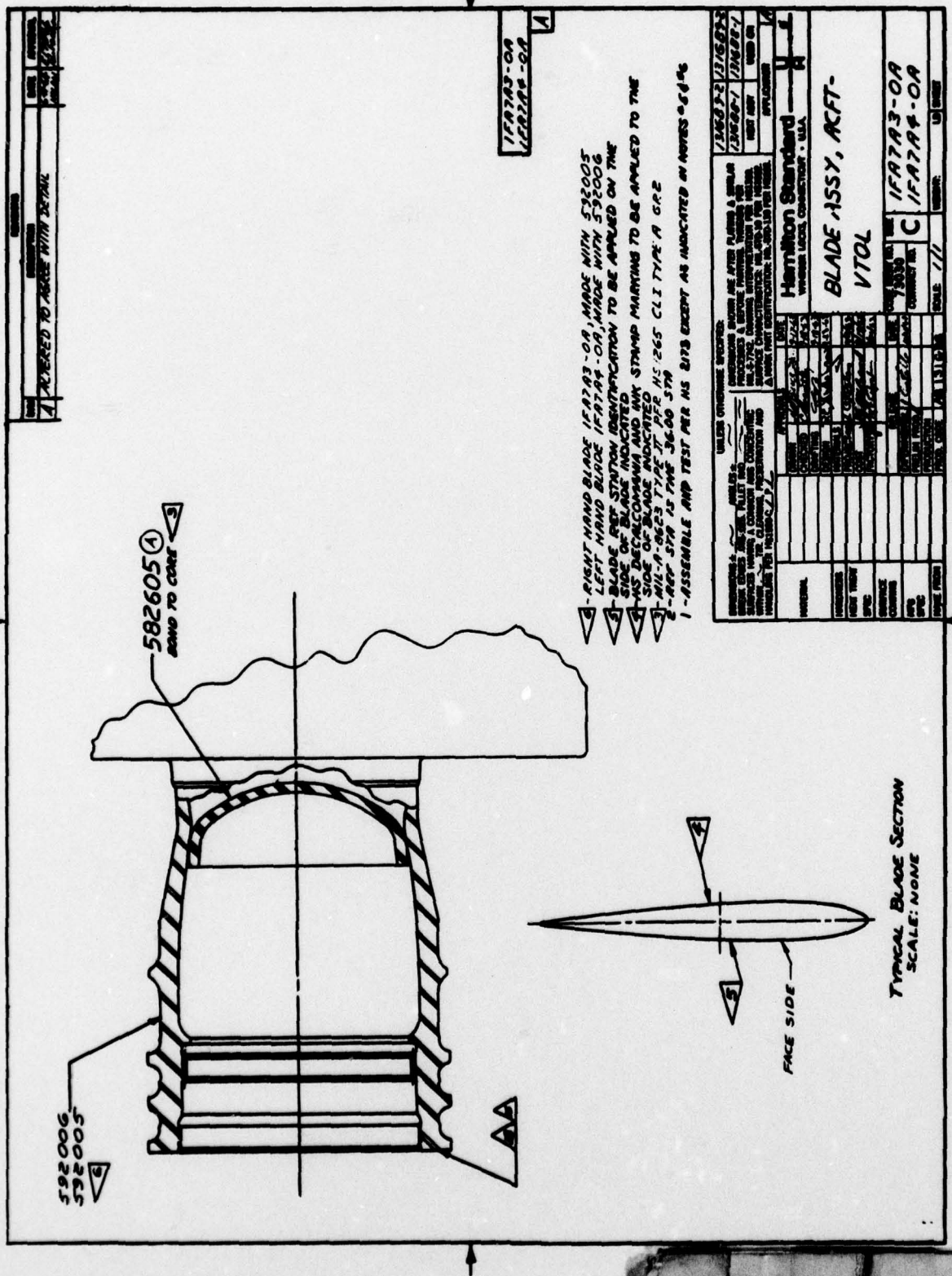

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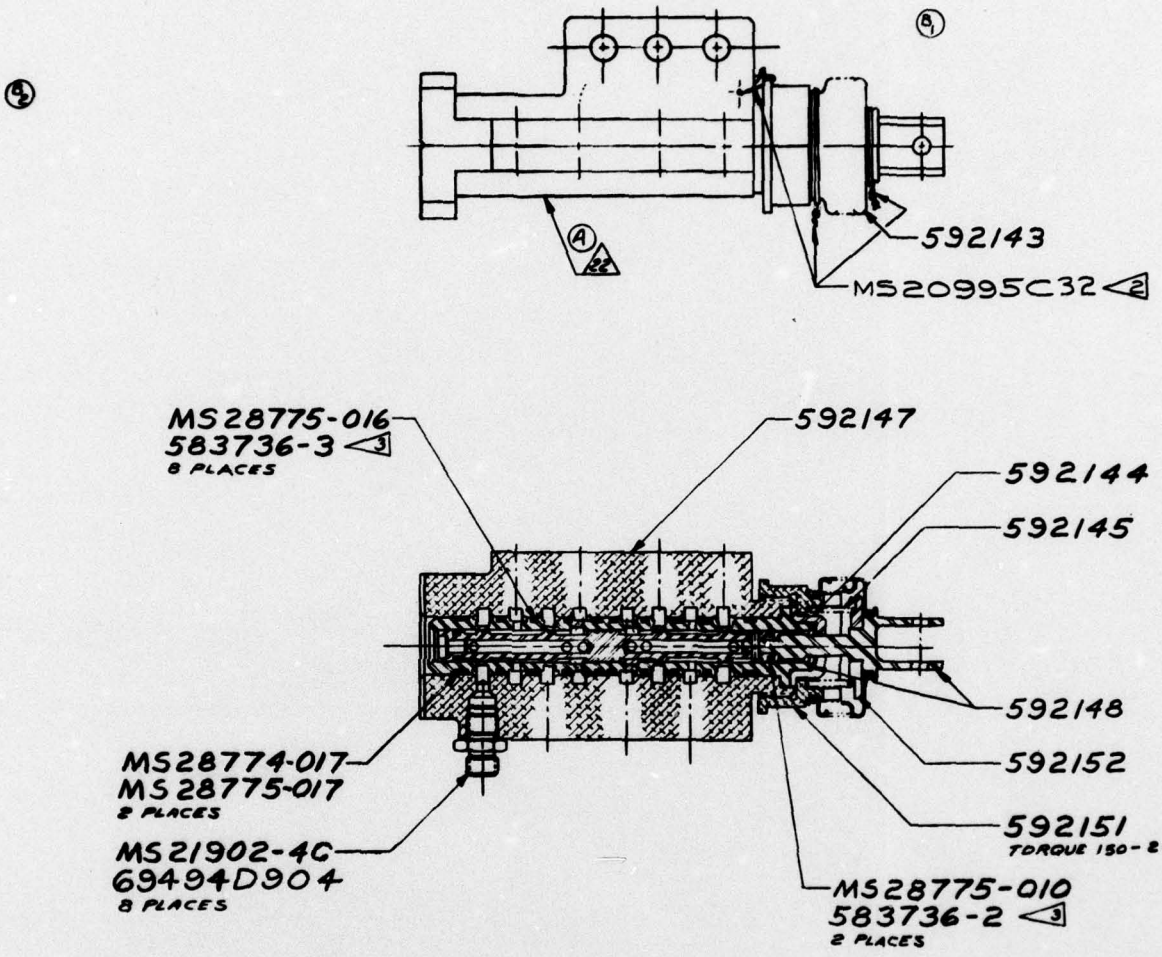

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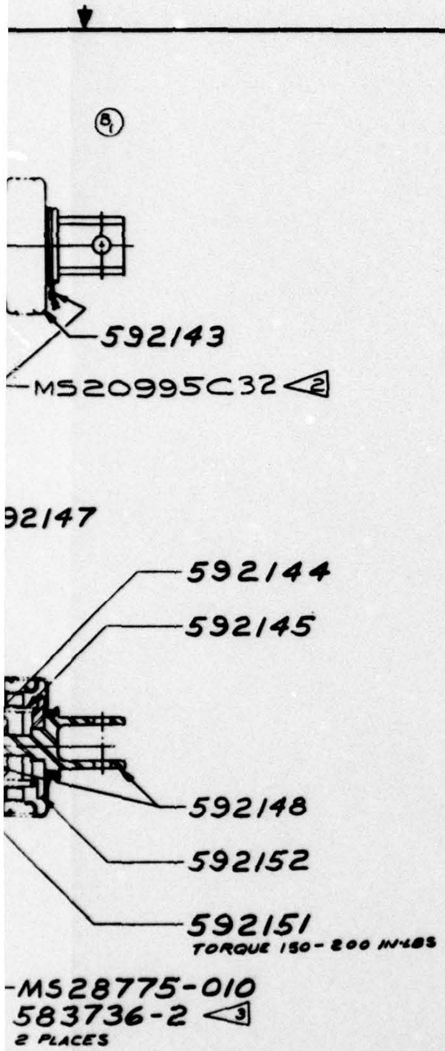

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592100
B

[3] VENDOR ITEM - SEE SOURCE CONTROL DRAWING
[2] ...WIRE PER MS 33540 PER HS 571
1-ASSEMBLE AND TEST PER HS 2578

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ± ~ ANGLES ± ~ EXCEPT FOR DRILL END FORMS, FILLET RADII ~ TO ~. SURFACES HAVING A COMMON AXIS CONCENTRIC WITHIN ~ TIR ~
MARK PART IDENTIFICATION: MIL-STD-130 PER HS333. DRAWING INTERPRETATION PER HS1360. CLEANING, PRESERVATION AND HANDLING PER HS1550-C LP 4

NEXT ASSY	USED ON
131689-2	131689-2
131688-1	131688-1

APPLICATION

MATERIAL	~
HARDNESS	~
HEAT TREAT SPEC	~
SURFACE COATING	~
HPS SPEC	~
MAKE FROM	~

DRAWN / CHECKED / DRAFTING / DESIGN / MATERIALS / PROJECT / COST / FACTORY — RELEASE: EXPERIMENTAL / PRELIM PROD. / PRODUCTION / PROD. CODE AAX

Hamilton Standard
WINDSOR LOCKS, CONNECTICUT · U.S.A.

DISTRIBUTOR VALVE ASSY, PROP

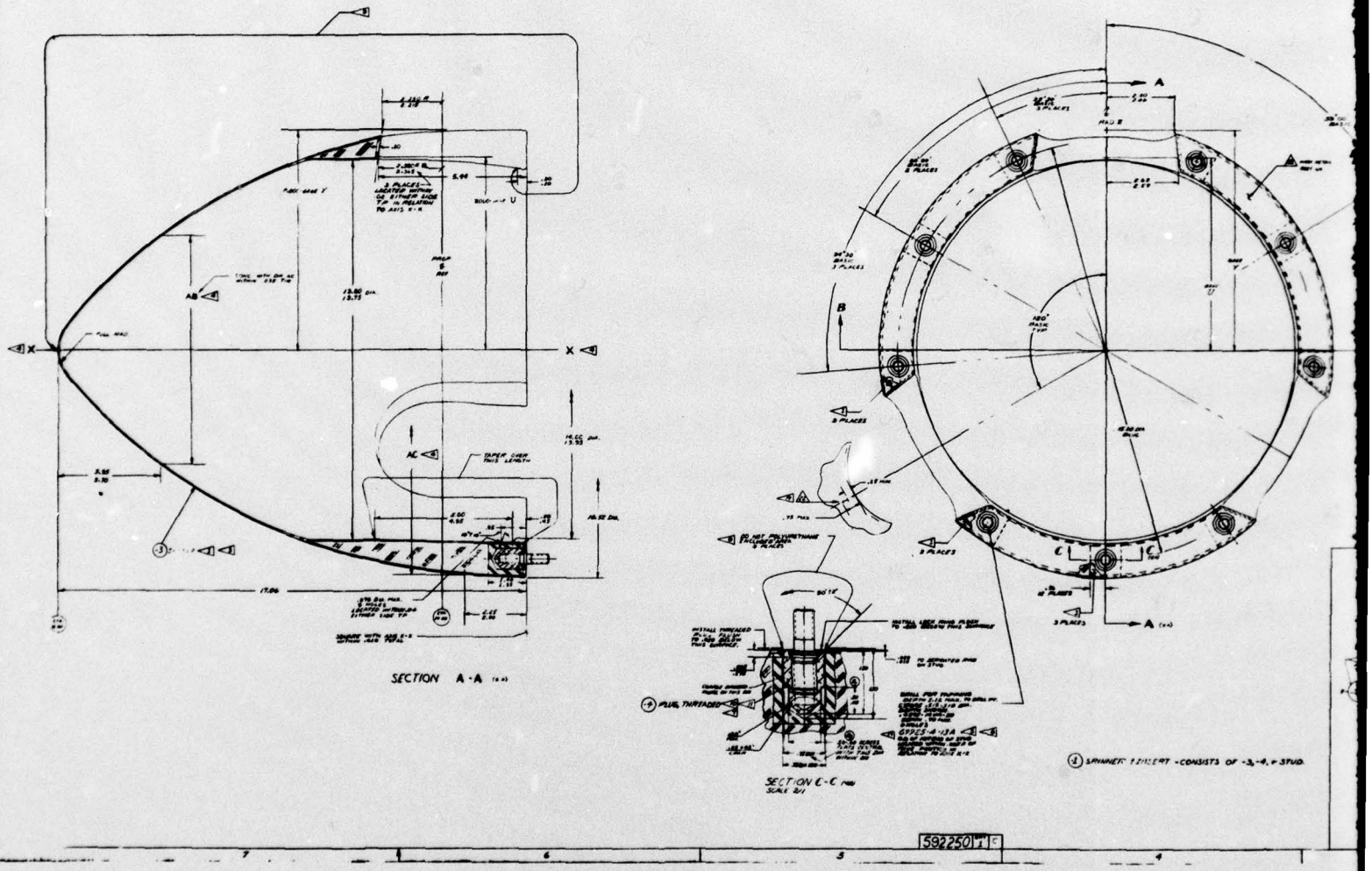
CODE IDENT NO. 73030 — CONTRACT NO. — SIZE D — 592100

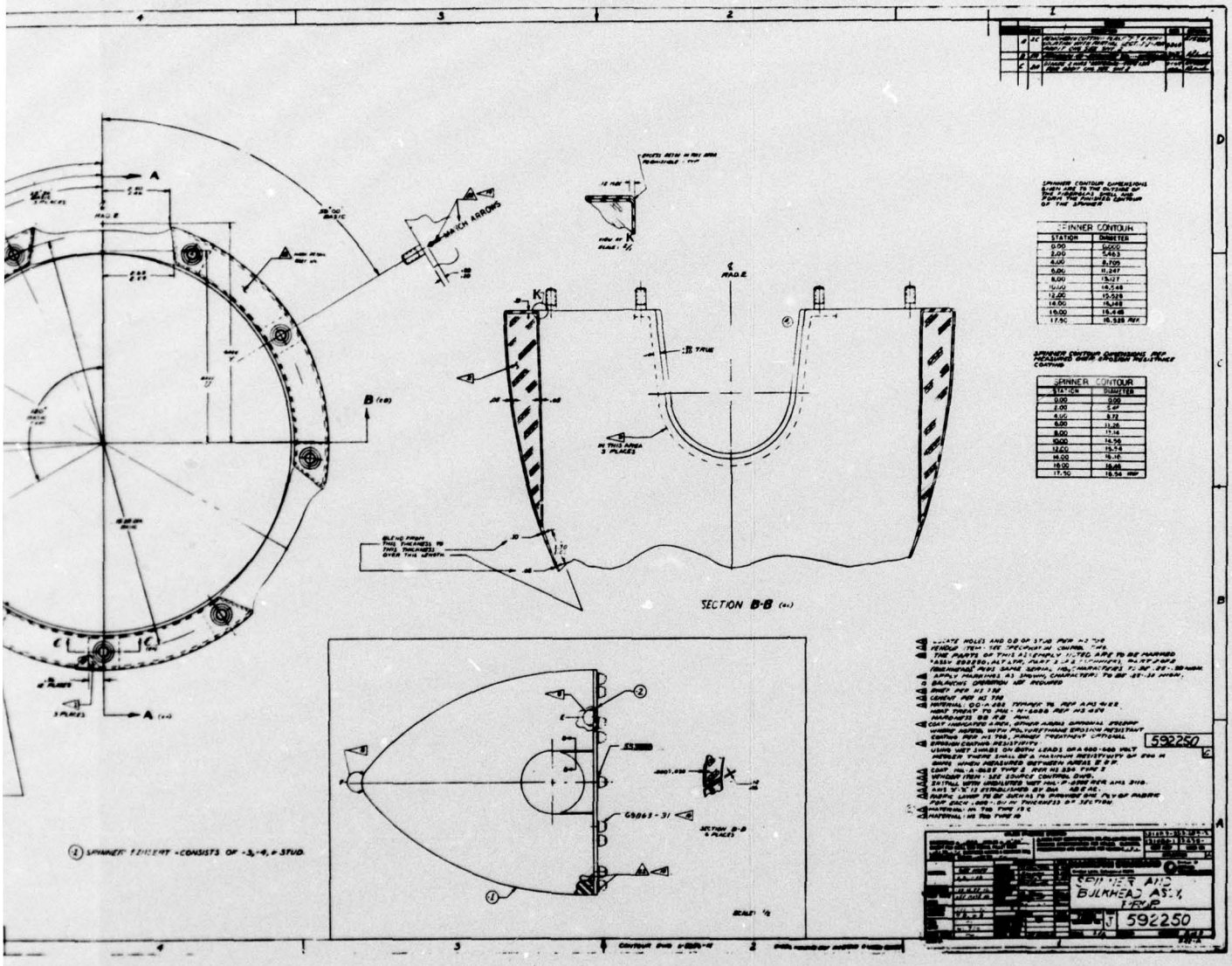
SCALE: 1/1 — WEIGHT: LB — SHEET

L8856-3

X-22A

Figure 6.





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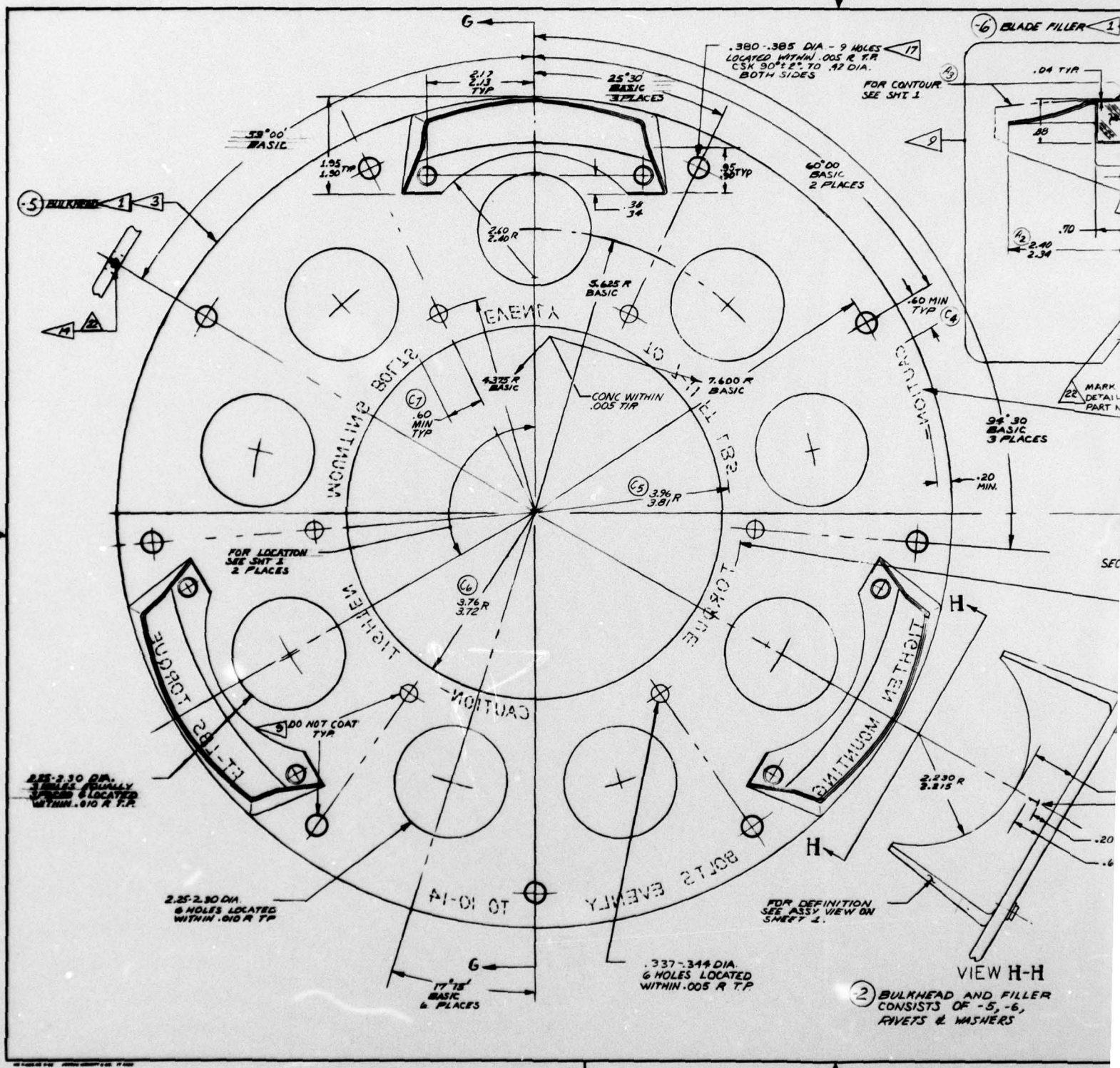

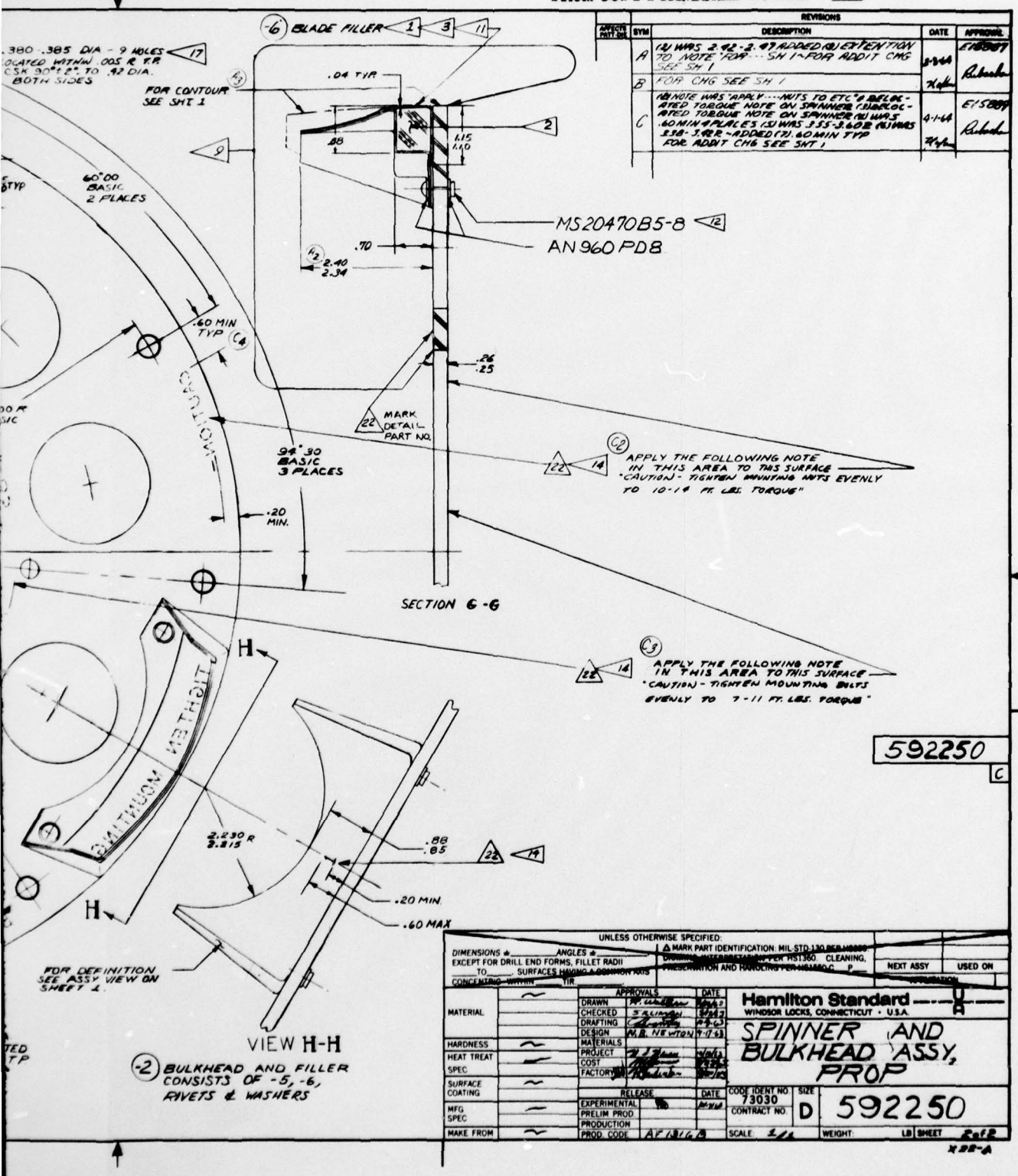

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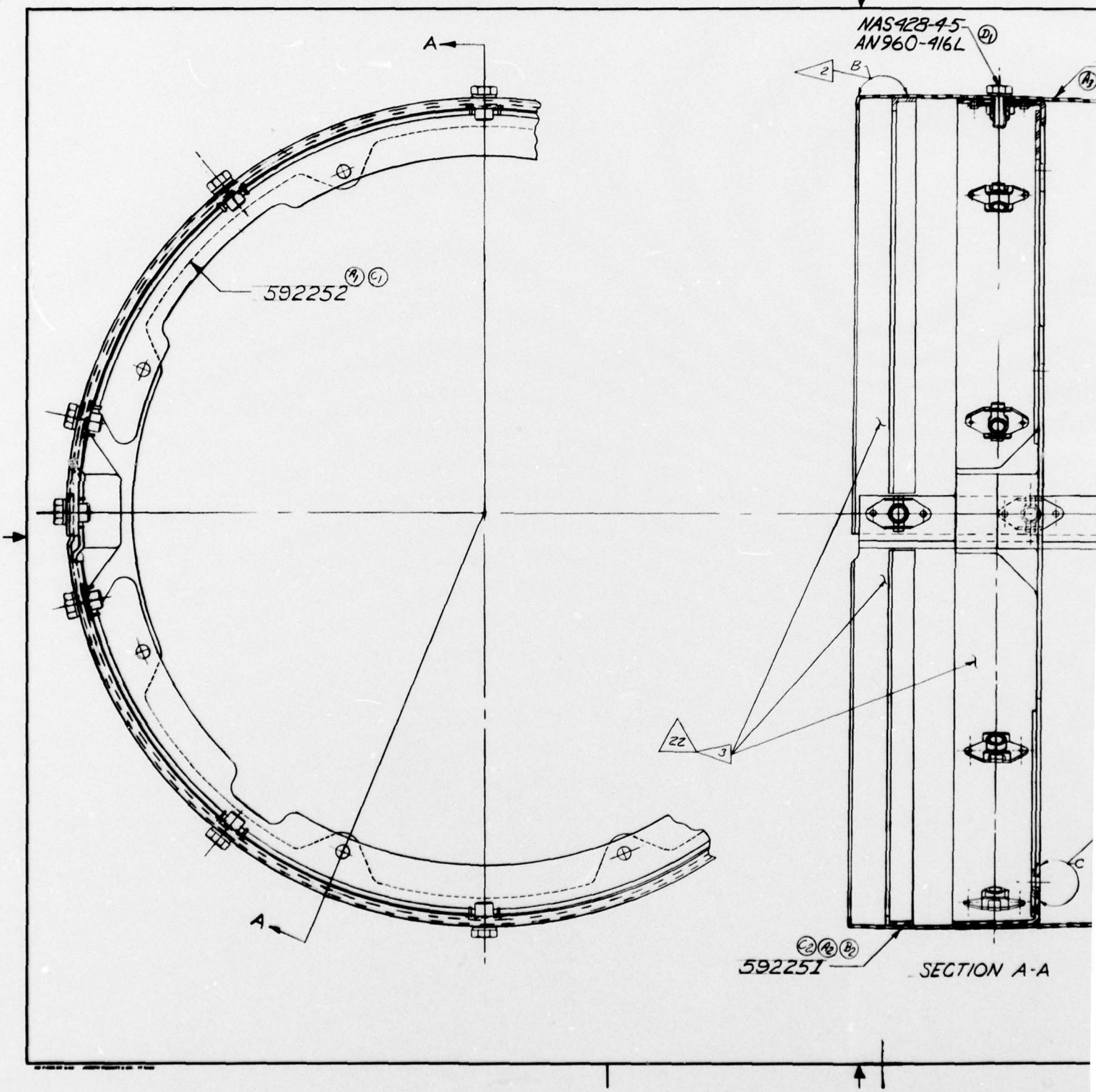

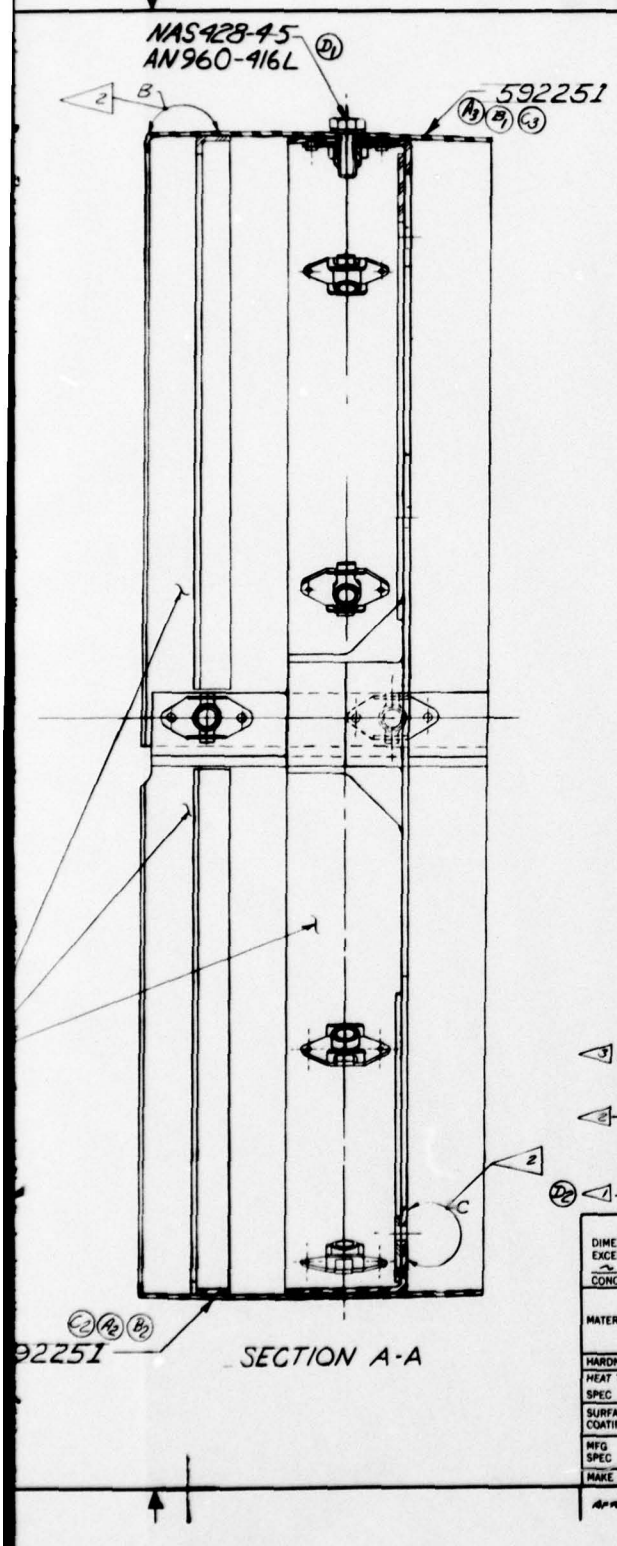

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	B	(1) & (2) ALTERED TO AGREE WITH DETAIL	4-1-63 [illegible]	[illegible]
	C	(1) & (2) & (3) ALTERED TO AGREE WITH DETAIL	5-24-63 [illegible]	[illegible]
	D	REMOVED (1) 69321A9J10 <1> & ADDED NAS 428-4-5 & AND AN 960-416L ~ REMOVED (2) NOTE ("VENDOR ITEM SEE SPEC CONTROL DRAWING"	7-1-64 HOLAN	E.R. BOYS [illegible]

592253 D

<1> THE PARTS OF THIS ASSY NOTED ARE TO BE MARKED "ASSY 592253, ALT. LET., PART 1 OF 3 (BRACKET), PART 2 OF 3 (AFTERBODY HALF), PART 3 OF 3 (AFTERBODY HALF)", PLUS SAME SERIAL NO., CHARACTERS TO BE .25-.38 HIGH

<2> EROSION COATING RESISTIVITY:
USING WET SWABS ON BOTH LEADS OF A 400-600 VOLT MEGGER THERE SHALL BE A MAXIMUM RESISTIVITY OF 600 K OHMS WHEN MEASURED BETWEEN AREAS B & C

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ± ~ ANGLES ± ~
EXCEPT FOR DRILL END FORMS, FILLET RADII ~ TO ~ SURFACES HAVING A COMMON AXIS CONCENTRIC WITHIN ~ TIR ~
△ MARK PART IDENTIFICATION: MIL-STD-130 PER HS333. DRAWING INTERPRETATION PER HS1360. CLEANING, PRESERVATION AND HANDLING PER HS1550-C / P /

131GB9-2	131GB9-3				
131000-1	131000-2				
NEXT ASSY	USED ON				
APPLICATION					

		APPROVALS		DATE
MATERIAL	~	DRAWN	R. WALTERS	9-8-62
		CHECKED	S. SULLIVAN	10-1-62
		DRAFTING	[illegible]	11-7-62
		DESIGN	A.O. MINTON	11-8-62
HARDNESS		MATERIALS		
HEAT TREAT SPEC		PROJECT	[illegible]	[illegible]
		COST	[illegible]	[illegible]
		FACTORY	[illegible]	[illegible]
SURFACE COATING	~	RELEASE		DATE
MFG SPEC		EXPERIMENTAL		[illegible]
		PRELIM PROD.		
MAKE FROM		PRODUCTION		
		PROD. CODE	AF 13168	

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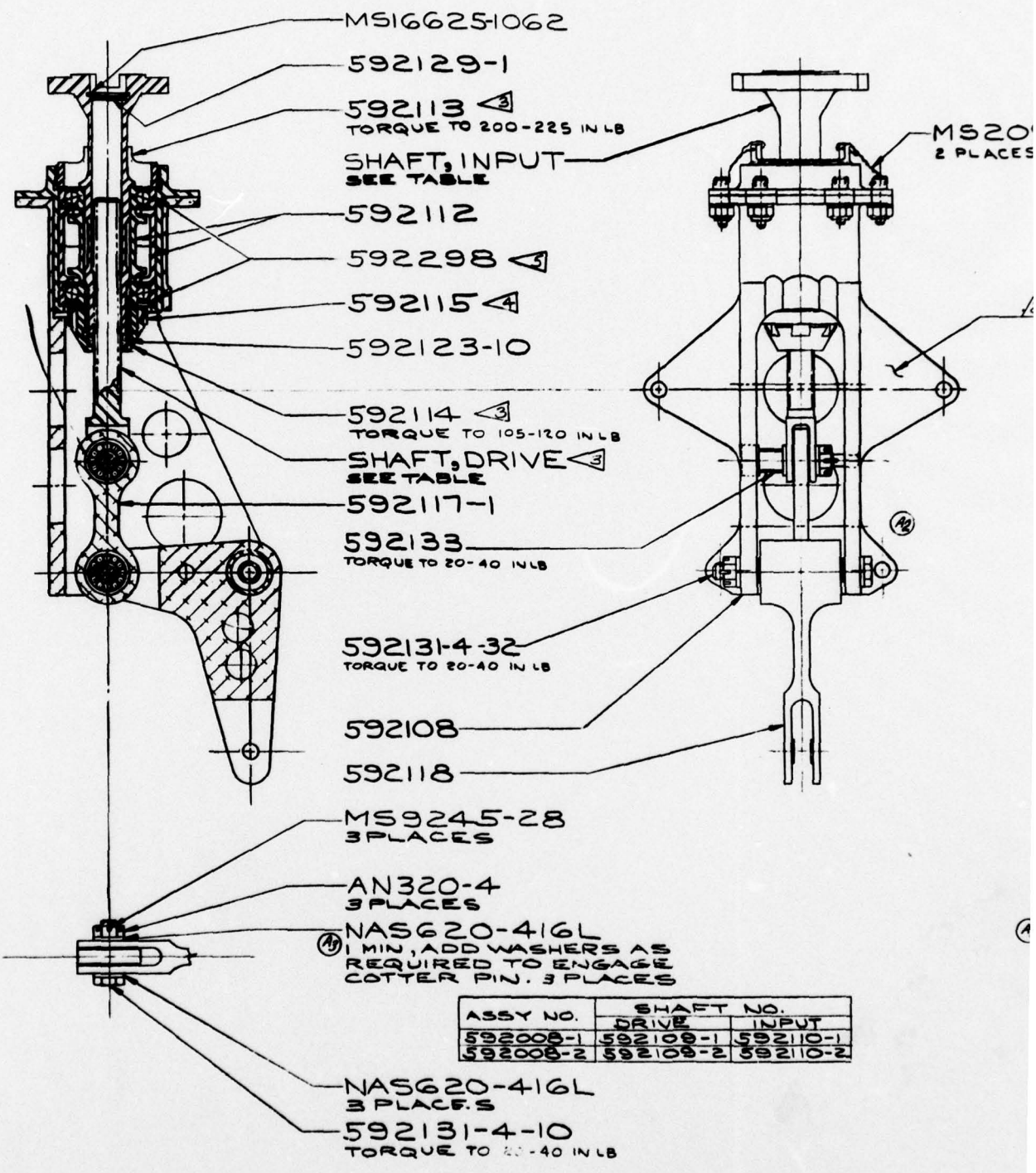
AFTERBODY ASSY, PROP

CODE IDENT NO.	SIZE	
73030	D	592253
CONTRACT NO.		
SCALE: 1/1	WEIGHT:	LB SHEET

AFTERBODY MOUNTING HOLES AN 960-10 & WASHERS AN 935-10

M32A

Figure 8.



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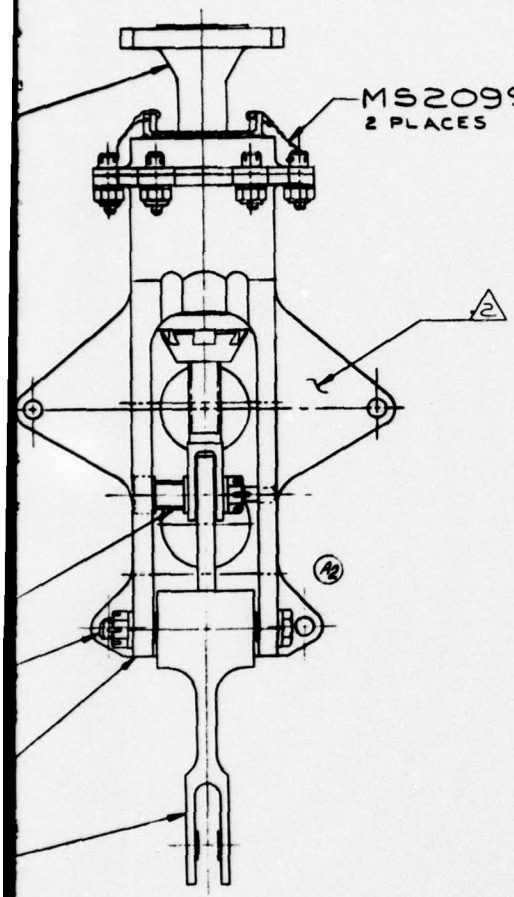

REVISIONS				
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592008 A

<2> - VENDOR ITEM, SEE SOURCE CONTROL DWG.
<4> - CRIMP PER HS 2578
(A1) <4> - COAT THDS & BRG SURFACES OF NUTS WITH MIL-T-5544
<4> - INSTALL WIRE MS 33540 PER HS 571
1 - ASSEMBLE PER HS 2578

SHAFT NO.	
DRIVE	INPUT
2109-1	592110-1
2109-2	592110-2

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ± ANGLES ±
EXCEPT FOR DRILL END FORMS, FILLET RADII
TO SURFACES HAVING A COMMON AXIS
CONCENTRIC WITHIN TIR
△ MARK PART IDENTIFICATION: MIL-STD-130 PER HS333.
DRAWING INTERPRETATION PER HS1360. CLEANING, PREservation AND HANDLING PER HS1550-C 1 P 2

131688-2	131689-2
131688-1	131688-1
NEXT ASSY	USED ON
APPLICATION	A

MATERIAL		ASSEMBLY		DATE
		DRAWN		12 APR
		CHECKED		11 APR
		DRAFTING		4-64
		DESIGN		4-64
HARDNESS		MATERIALS		
HEAT TREAT		PROJECT		4 Apr
SPEC		COST		4-11-64
		FACTORY		4-22-64
SURFACE COATING		RELEASE		DATE
		EXPERIMENTAL		4-64
MFG SPEC		PRELIM PROD.		
		PRODUCTION		
MAKE FROM		PROD. CODE		

Hamilton Standard U A
WINDSOR LOCKS, CONNECTICUT • U.S.A.

CONVERTER ASSY, PROP

CODE IDENT NO.	SIZE	
73030	D	592008
CONTRACT NO.		
SCALE: 1/1	WEIGHT: LB	SHEET

L-8856-19

Figure 9.

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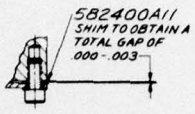
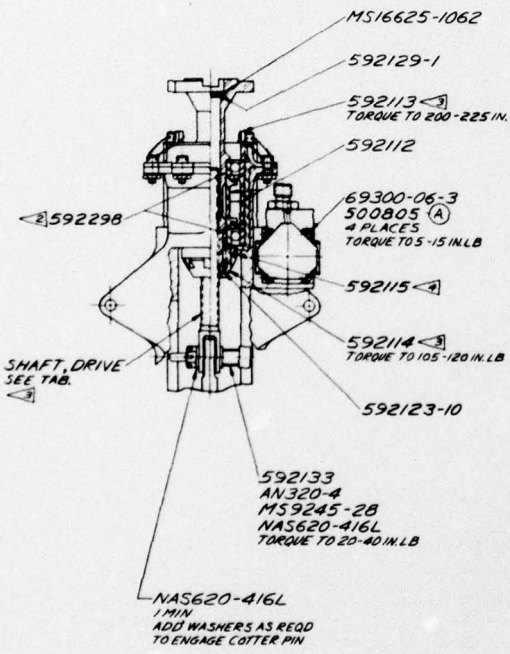
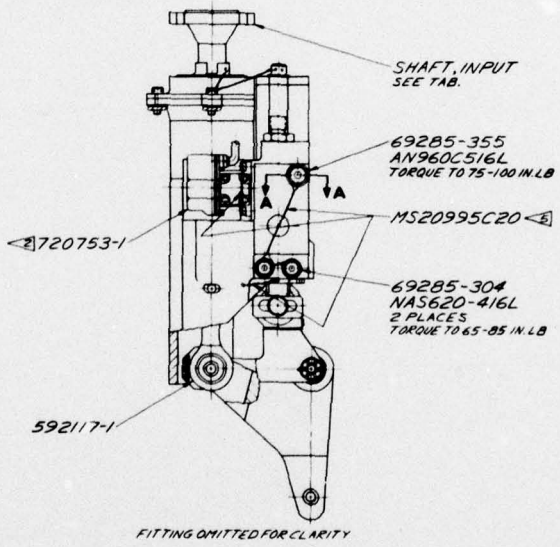
-2	C	-2



SECTION A-A





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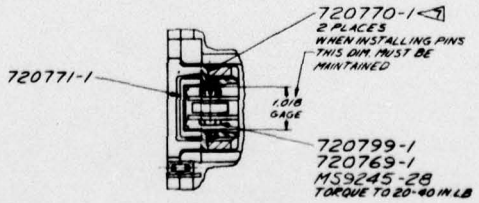

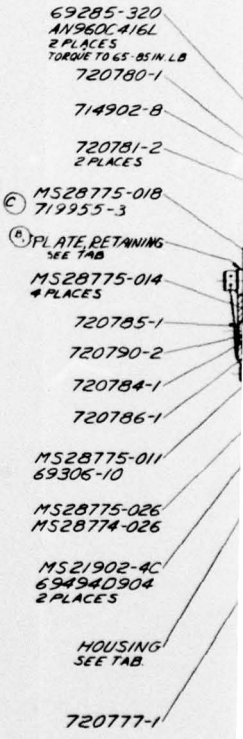

ASSY NO.	PART REV LTR	PARTS LIST NO.	HOUSING	SHAFT, DRIVE	SHAFT, INPUT	PLATE, RETAINING	
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-2	C	-2	720768-1	-2	-2	-1	LH

LTR	DESCRIPTION
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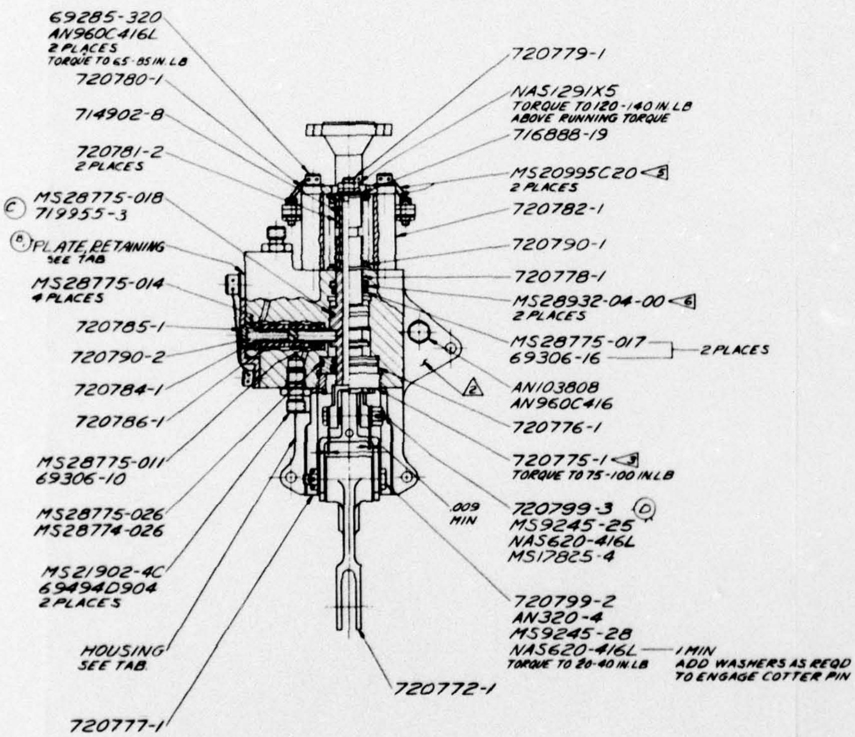
B	[illegible]
C	[illegible]
D	WAS 577896-21, ADDED MS17825-4, DELETED 6 PLACES



726600

6. INSTL WITH WET MIL-P-8585 PRIMER AS PKG - UNDILUTED
5. CEM HS1265 CL II TYPE A GR 2 OPTIONAL. NO ADHESIVE PERMISSIBLE ON WIPER ID
4. LOCKWIRE PER AS567
3. CRIMP PER HS
2. COAT THDS & BRG SURF. OF NUTS WITH MIL-T-5544
2. VENDOR ITEM - SEE SOURCE CONT DWG
1. ASSEMBLE PER HS

HAMILTON STANDARD

CONVERTER ASSY, PROPELLER

73030 726600

REF: L-8856-32, 592008

X-22A

Figure 10.

As it was not the intention of the NADC to manufacture new P/N 726600 type Converter assemblies for this program, Calspan made available two assemblies from residual BAC transmission test stand material and two assemblies from propellers installed on the number two aircraft. The two assemblies from the test stand, one each of P/N's 726600-1 and -2 were received in July of 1977 and the two assemblies from the aircraft, again, one each of P/N's 726600-1 and -2 in April of 1978.

Support Tools

None of the tools from the BAC conducted 1960's program were available. It was necessary to design and fabricate a number of assembly, disassembly and handling tools to compliment those produced under contract N00019-75-C-0199 and subsequently inventoried under Contract N00019-75-C-9005 when the former contract was closed. Table 3 is a summary listing of all the special tools made to facilitate overhaul activities.

TABLE 3. SUPPORT TOOLS

Part Number	Part Name	Where Used
GS 10081	Fixture	1FA7A3-0A
		1FA7A4-0A
GS 10095	Wrench	592214
GS10101-2	Bushing	1FA7A3-0A
		1FA7A4-0A
MS 19068-003-CT-001*	Wrench	MS 19068-003
1FA7A4-0A-CT-001	Template	1FA7A3-0A, 1FA7A4-0A
131GB8-1-CT-001*	Lifter	131GB9-2, -4
		131GB8-1, -3
133X-84-CT-001*	Support	592089
		592072
582526-CT-001*	Wrench	582526
582555-2-CT-001*	Driver	582555-2
582555-5-CT-001*	Driver	582555-5
582579-CT-001	Wrench	582579
583150-CT-001*	Wrench	583150
583736-2-CT-001	Loading Mandrel	583736-2
583736-2-CT-002	Sizing Mandrel	583736-2
583736-3-CT-001	Loading Mandrel	583736-3
583736-3-CT-008	Sizing Mandrel	583736-3
592000-CT-001*	Driver	592061
		592200
		592080

TABLE 3. SUPPORT TOOLS (Continued)

Part Number	Part Name	Where Used
592001-CT-001*	Adapter	592001
		592002
592002-CT-001*	Lifter	592018
		592019
		592003-2
592013-CT-001	Wrench	592013
592014-CT-001	Support Sleeve	592014-1, -2
592014-CT-002	Clamp/Anvil/Spacer	592014-1, -2
592014-CT-015	Plug	592014-1, -2
592015-CT-001*	Adapter	592015
592016-CT-002*	Puller	592016
		592017
592017-CT-001*	Dummy Gear	592016
		592017
592017-CT-002*	Driver	592016
		592017
592018-CT-003	Fixture	592018
592018-CT-004	Driver	592019
592018-CT-005*	Wrench	592018
		592053
		592019
592019-CT-001	Fixture	592019
592019-CT-002	Lifter	592018
		592019
592020-CT-001*	Driver	592020/SK55131
592020-CT-002*	Puller	
592021-CT-001*	Driver	592021
592023-CT-001*	Adapter	592023
592027-CT-001*	Wrench	592027
592033-CT-001*	Wrench	592033
592041-CT-001*	Puller	592041
592043-CT-001*	Driver	592041
		592043-1
		592154-1
		592043-2
592044-CT-001*	Driver	592044
		562043-2
592051-CT-001	Driver	592051-1
592053-CT-001*	Wrench	592053

TABLE 3. SUPPORT TOOLS (Continued)

Part Number	Part Name	Where Used
592060-CT-001	Puller	592060-1, -2
592068-CT-001	Wrench	514288
592080-CT-001*	Driver	592080
592084-CT-001*	Holder	592084
592087-CT-001*	Wrench	592086
		592087
562093-CT-001*	Adapter	592093
592113-CT-001	Wrench	592113
		592151
592114-CT-002	Wrench	592114
592118-CT-001	Spacer	592118
592153-CT-001*	Driver	592153
592202-CT-001*	Wrench	592202
592204-CT-001	Pin	592204
592214-CT-001	Wrench	592214
592298-CT-001	Driver	592298
69316A5-CT-001*	Wrench	69316A5
719955-3-CT-001	Loading Mandrel	719955-3
719955-3-CT-002	Sizing Mandrel	719955-3

*Produced under Contract N00019-75-C-0199

Spare Part Provisioning

Available records of prior operating experience were reviewed for the purpose of establishing a provisioning kit of parts such as seals, locking devices, etc. for incorporation at overhaul. Then, the residual support hardware resulting from the BAC conducted 1960's program and stored at HS under Contract N00019-75-C-9005 was inventoried and found to be inadequate to perform a complete overhaul. Accordingly, additional support hardware was procured. Actual disassembly experience necessitated the procurement of still additional support hardware. Table 4 summarizes the kit in its final form. Appendix A contains a listing of the residual support hardware, as of the date of this report, under Contracts N00019-75-C-9005 and N62269-77-C-0035. The existance of the four residual Gear Reduction and Propeller assemblies is not reflected in either listing because neither the extent of cannibalization nor the condition of the parts was established as part of this contract.

TABLE 4. SPARE PARTS PROVISIONING KIT

QUANTITY	PART NUMBER	PART NAME	WHERE USED
378	69992A12	Ball	131GB8/131GB9
6	580384-1	Packing	131GB8/131GB9
3	69490C426	Packing	131GB8/131GB9
9	MS9245-21	Cotter Pin	131GB8/131GB9
3	69494C154	Packing	131GB8/131GB9
3	584159	Lock cup	131GB8/131GB9
3	592213	Lock cup	131GB8/131GB9
AR	MS20995C20	Lockwire	131GB8/131GB9
AR	MS20995C32	Lockwire	131GB8/131GB9
3	MS20364-1032	Nut	131GB8/131GB9
1	69494C252	Packing	131GB8/131GB9
1	69494C152	Packing	131GB8/131GB9
4	592141	Bearing	131GB8/131GB9
8	MS9245-28	Cotter Pin	131GB8/131GB9
17	69494D904	Packing	131GB8/131GB9
3	592111-1	Bearing	131GB8/131GB9
2	592124	Bearing	131GB8/131GB9
12	MS21922-4	Sleeve	131GB8/131GB9
12	MS21921-4C	Nut	131GB8/131GB9
1	69445A3	Identification Plate	131GB8/131GB9
6	582400A11	Laminated Shim	131GB8/131GB9
1	NAS1291X3	Nut	131GB8/131GB9
2	582400A14	Laminated Shim	131GB8/131GB9
1	MS20364-1032A	Nut	131GB8/131GB9
2	582400A6	Laminated Shim	131GB8/131GB9
3	580385	Spacer	131GB8/131GB9
1	MS9015-04	Nut	131GB8/131GB9
2	AN320-4	Nut	131GB8/131GB9
1	592205	Key Washer	592000
4	582313-220G2	Seal	592000
4	MS24665-149	Cotter Pin	592000
2	MS9241-331	Packing	592000
1	69494B24	Packing	592000
1	583154	Key Washer	592000
4	69494D6	Packing	592000
4	69429A6	Retaining Ring	592000
1	577049H15	Washer	592000
1	582400A5	Laminated Shim	592000
2	69494D231	Packing	592000
2	MS28775-119	Packing	592000

TABLE 4. SPARE PARTS PROVISIONING KIT (Continued)

QUANTITY	PART NUMBER	PART NAME	WHERE USED
4	MS28774-119	Retaining Ring	592000
2	583736-8	Glyd Ring	592000
1	MS28775-025	Packing	592000
2	69915-6	Gasket Seal	592000
1	592301-1	Lip Seal	592000
1	592203	Key Washer	592000
4	69494D32	Packing	592000
4	69494D33	Packing	592000
4	592080	Face Seal	592000
6	MS28775-135	Packing	592000
8	69429A135	Retaining Ring	592000
6	MS28775-124	Packing	592000
8	69429A123	Retaining Ring	592000
9	69915-4	Gasket Seal	592000
1	592070	Duplex Ball Bearing	592000
1	MS19070-003	Key Washer	592000
1	720752-26	Packing	592000
1	582555-2	Lip Seal	592001/592002
1	582555-5	Lip Seal	592001/592002
1	592024	Key Washer	592001/592002
1	582551	Key Washer	592001/592002
1	592052	Key Washer	592001/592002
1	592036	Key Washer	592001/592002
1	592051	Face Seal and Rotor	592001/592002
1	592022	Laminated Shim	592001/592002
1	592069	Laminated Shim	592001/592002
11	MS9241-011	Packing	592001/592002
3	MS9241-114	Packing	592001/592002
1	MS9241-160	Packing	592001/592002
1	69490D43	Packing	592001/592002
1	MS9241-041	Packing	592001/592002
1	MS9241-280	Packing	592001/592002
1	MS9241-259	Packing	592001/592002
1	MS9241-159	Packing	592001/592002
1	MS9241-246	Packing	592001/592002
12	583604	Cup Retainer	592001/592002
4	MS9241-137	Packing	592001/592002
1	MS9241-121	Packing	592001/592002
2	MS9241-014	Packing	592001/592002

TABLE 4. SPARE PARTS PROVISIONING KIT (Continued)

QUANTITY	PART NUMBER	PART NAME	WHERE USED
3	MS9241-016	Packing	592001/592002
3	MS9241-022	Packing	592001/592002
1	MS9241-110	Packing	592001/592002
1	MS9241-117	Packing	592001/592002
2	MS9241-012	Packing	592001/592002
2	MS9241-115	Packing	592001/592002
2	MS9241-112	Packing	592001/592002
1	MS9241-123	Packing	592001/592002
1	MS9241-213	Packing	592001/592002
2	MS9241-010	Packing	592001/592002
1	MS9241-127	Packing	592001/592002
1	MS9015-08	Drain Plug	592001/592002
3	582605	Core Seal	1FA7A3/1FA7A4
2	MS28774-017	Packing	592100
2	MS28775-017	Packing	592100
8	MS28775-016	Packing	592100
2	MS28775-010	Packing	592100
8	583736-3	Ring	592100
2	583736-2	Ring	592100
1	592143	Boot	592100
9	69863-31	Nut	592250
14	NAS428-4-5	Bolt	592253
14	69804-5B	Nut	592253
28	MS20426D3-4	Rivet	592253
2	592116	Bearing	726600
6	MS21045-08	Nut	726600
1	592115	Key Washer	726600
1	592123-10	Felt Washer	726600
1	MS9245-25	Cotter Pin	726600
4	NAS1291X5	Nut	726600
1	MS28774-026	Retaining Ring	726600
1	MS28775-011	Packing	726600
4	MS28775-014	Packing	726600
2	MS28775-017	Packing	726600
1	MS28775-018	Packing	726600
1	MS28775-026	Packing	726600
2	MS28932-04-00	Felt Strip	726600
1	719955-3	Seal Ring	726600
2	69306-16	Seal Ring	726600
1	69306-10	Seal Ring	726600

Spare Parts Provisioning (continued)

As a consequence of the approximate 11 year time span from the original period of manufacture until initiation of the support hardware procurement activity associated with this program, several parts were no longer available from the initial sources. It was thus necessary to develop alternate procurement sources for two face type seals, P/N's 592051 and 592080, two shaft type seals, P/N's 582555-2 and 582555-5, and a protective boot, P/N 592143.

The original face seals were procured from Chicago Rawhide Manufacturing Company of Chicago, Illinois. However, under a 1971 agreement, Chicago Rawhide transferred their face seal product line to GITS Brothers Manufacturing Company of Bedford Park, Illinois. A design change in the P/N 592051 was also required as the result of the change in suppliers. In the original Chicago Rawhide design the metal shell or housing surrounding the carbon sealing element was made of aluminum and employed cemented internal lugs to restrain the carbon element from rotating. The GITS design involves a stainless steel shell and welded/brazed internal lugs. The GITS seals were installed with strontium chromate, in accordance with standard HS practice, to inhibit dielectric activity between the stainless steel shell and its magnesium mounting plate. An appropriate experimental engineering change, E121214, was published on 29 July 1977 to add GITS to the approved vendor listing and to document the design change.

The two shaft seals were also originally supplied by Chicago Rawhide Manufacturing Company but they declined the opportunity to produce additional shaft seals because plant reorganization had eliminated the required molding machines and tooling. However, Chicago Rawhide made their engineering drawings available for developing a second source. Parker Seal Company of Culver City, California, a current HS supplier of similar parts, agreed to produce the necessary seals to the original specifications with the stipulation that HS would be responsible for the design. This was agreed to and an appropriate experimental engineering change, E121796, was published on 19 December 1977 to add Parker to the list of approved vendors.

The original source for the protective boot was A and A Manufacturing Company of Milwaukee, Wisconsin. A and A was the supplier but a company called Midwest Rubber of Deckerville, Michigan did the actual molding. Again, an experimental engineering change was written, E121214, dated 29 July 1977, to add Midwest Rubber to the approved vendor listing.

Disassembly Inspection - Disposition

Existing historical logs and prior inspection records for the eight assemblies were retrieved from storage and reviewed for such detail items as compliance with mandatory engineering changes, assembly torques, gear pattern, and bearing preload shimming calculations in order to reacquaint engineering, assembly and inspection personnel with the as-delivered condition of the assemblies.

Although it was desired that the four assemblies with the lowest accumulated time be overhauled, selection was influenced by preservation effectiveness during the 11-year storage period, the extent of damage resulting from the hard landing of the number one aircraft, the extent of cannibalization prior to receipt at HS, and a general assessment of the hardware based on a physical examination. Based on this detail appraisal Gear Reduction and Propeller Assembly serial numbers (S/N's) 222418, 222411, 222417, and 222414 were selected and subjected in turn to a complete analytical examination consisting of the following:

- "Dirty" assessment of each part in the as-disassembled condition.
- Non-destructive magnetic particle and/or fluorescent penetrant inspection of metal parts and X-ray of blades.
- Dimensional inspection of selected key features.
- "Clean" assessment of the condition of each part.
- Photographic documentation of those parts exhibiting damage.

The examination was performed by an engineering team which included members involved in the 1960's BAC design and development program.

Gear Reduction and Propeller Assembly

P/N 131GB9-2, S/N 222418

This assembly had been removed from the left-forward-position, number one aircraft, after a hard landing incident in August of 1966 after having accumulated 35.8 operating hours. This area of the aircraft was reported to be undamaged by the incident.

Disassembly revealed the preservation and storage techniques to be adequate and the general condition of the detail parts to be satisfactory. Magnetic particle and/or fluorescent penetrant inspection of metal parts did not reveal any distress. However, a dye check of the molded in place aluminum inserts in the fiberglass spinner, showed indications in one of nine inserts. X-ray inspection revealed the presence of nonstructural sheath tip cracks in one blade.

Thirty-five detail parts and one subassembly, involving 32 detail parts, were missing, 19 parts were damaged or worn and two parts were not in accordance with required engineering changes which were generated after BAC took custody of the assembly in November 1964. Table 5 delineates the status of the above detail parts and the subassembly. Expendable items, such as seals, lock devices, etc., which are normally replaced at overhaul are excluded from this listing. All but eight of the missing parts were obtainable from HS and Calspan spare part inventories or from the four remaining assemblies. Replacements for the two parts not in accordance with required changes were obtained from the same spare part inventories. The replacement for the superseded Converter subassembly was obtained from the Calspan spare part inventory. However, as this replacement contained a part that exhibited wear, the total of damaged or worn parts became 20. A subsequent contract modification was processed on 22 December 1977 to authorize manufacture of replacements for the missing parts.

TABLE 5. PART INSPECTION - DISPOSITION SUMMARY

131GB9-2 S/N 222418

Part Number	Part Name	Quantity	Disassembly Inspection Status	Disposition
592102	Hydraulic Tube	1	Missing	Remanufacture
592103	Hydraulic Tube	1	Missing	Remanufacture
592104	Hydraulic Tube	1	Missing	Remanufacture
592105	Hydraulic Tube	1	Missing	Remanufacture
592106	Hydraulic Tube	1	Missing	Remanufacture
592107	Hydraulic Tube	1	Missing	Remanufacture
MS21921-4C	Flareless Nut	12	Missing	Replace from inventory
MS21922-4	Flareless Sleeve	12	Missing	Replace from inventory
592060-2	Lube Pump	1	Missing	Replace from residual assys.
592068	Drive Gear	1	Missing	Replace from residual assys.
514287	Retaining Nut	1	Missing	Replace from residual assys.
514288	Lock Ring	1	Missing	Replace from residual assys.
592119-1	Eye Bolt and Bearing	1	Missing	Replace from residual assys.
592119-2	Eye Bolt and Bearing	1	Missing	Replace from residual assys.
NAS509L6	Jam Nut	1	Missing	Replace from residual assys.
592132	Body	1	Missing	Replace from residual assys.
NAS1193-6C	Locking Device	2	Missing	Replace from residual assys.
NAS509-6	Jam Nut	1	Missing	Replace from residual assys.
537458-5	Rod End Bearing	1	Missing	Replace from residual assys.
MS20364-1032A	Lock Nut	1	Missing	Replace from inventory
MS21902-4C	Flareless Union	4	Missing	Replace from inventory
592137	Potentiometer	1	Missing	Replace from inventory
69494D904	Packing	4	Missing	Replace from inventory
592015	Chip Detector	1	Missing	Replace from inventory
NAS1272H4	Bolt	12	Missing	Replace from inventory

TABLE 5. PART INSPECTION - DISPOSITION SUMMARY (continued)

Part Number	Part Name	Quantity	Disassembly Inspection Status	Disposition
592003-2	Flat Washer	12	Missing	Replace from inventory
592131-4-13	Special Bolt	1	Missing	Replace from inventory
AN103816	Screw	4	Missing	Replace from inventory
592121	Support	1	Missing	Replace from inventory
592082	Check Valve	1	Missing	Remanufacture
NAS428-4-5	Bolt	14	Missing	Replace from inventory
AN960-4161	Washer	14	Missing	Replace from residual assys.
592252	Bracket and Plate	1	Missing	Replace from residual assys.
69863-31	Nut	9	Missing	Replace from inventory
553888	Special Washer	9	Missing	Remanufacture
592008-2	Converter Assembly	32 parts in Assy.	Missing	Superseded by 726600-2 and end assembly reidentified as 131GB9-4.
592089	Feedback Rod	1	Not in accordance with required change.	Replace from inventory
592014-2	Propeller Barrel	1	Worn	Rework
592048	Front Housing	1	Worn	Repair
592041	Seal Sleeve	1	Worn	Rework
592044	Bearing Spacer	1	Worn	Rework
577049H15	Flat Washer	1	Worn	Replace from inventory
592208	Torque Bracket	1	Chafed	Rework
592083	Retaining Ring	1	Worn	Rework
592074	Rotating Sleeve	2	Worn	Rework
592078	Special Bolt	9	Not in accordance with required change.	Replace from inventory

TABLE 5. PART INSPECTION - DISPOSITION SUMMARY (continued)

Part Number	Part Name	Quantity	Disassembly Inspection Status	Disposition
592061	Transfer Housing	1	Worn	Repair
592201-1	Bearing Spacer	1	Damaged	Replace from residual assys.
592251	Afterbody	1	Damaged	Replace from residual assys.
69445A3	Identification Plate	1	Damaged	Replace from inventory
583155	Bleed Screw	4	Worn	Remanufacture
592011	Blade Trunnion	3	Chafed	Rework
592088	Piston Rod Support	1	Chafed	Rework
592250-1	Spinner	1	Damaged	Rework
592094	Piston Rod	1	Galled	Rework
583150	Retaining Nut	1	Galled	Rework
592006	Propeller Blade	3	Damaged	Repair
720786-1	Valve Sleeve	1	Chafed	Rework

Following is a general description of the discrepant parts listed in Table 5.

Feedback Rod - P/N 592089

The rod was not in accordance with experimental engineering change E28633, published 11 December 1967, to improve stiffness. The correct revision letter shaft was drawn from residual inventory and incorporated. See Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the rod within the assembly.

Propeller Barrel - L.H. - P/N 592014-2

The barrel tailshaft exhibited a band of wear from contact with its corresponding P/N 582555-2 shaft seal. The wear depth was superficial and was removed by lapping without significantly reducing the thickness of the chrome surface coating. See Figure 11 for typical appearance - Figure 4, the Gear Reduction - L.H. subassembly drawing, for orientation of the barrel in the assembly.

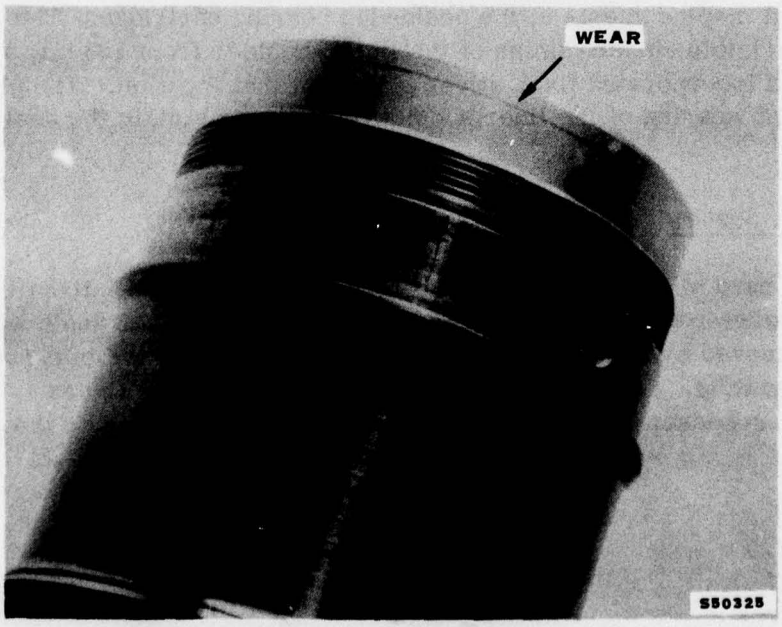


Figure 11. Propeller Barrel Tailshaft

Housing and Inserts - P/N 592048

The magnesium front gear reduction housing incorporates a hardened steel bearing liner. The shoulder of the liner, which supports the P/N 592154 tapered roller preload bearing, had a wear pattern of concentric circular rings that were apparently caused by rotation of the bearing outer race. The depth of wear was approximately 0.001 inch. See Figure 12 for typical appearance - Figure 4, the Gear Reduction - L.H. subassembly drawing,for orientation of the liner in the assembly. The analytical evaluation of the rotation problem produced two design changes. The first change involved preloading as that is the mechanism whereby bearing race rotation is prohibited. In the original design preload was accomplished by means of a laminated shim whose thickness is established by relating the actual stack-up dimensions of the affected bearing cartridge parts; i.e., P/N's 592154, 592044, 592043, and 592067 to the P/N 592048 housing to achieve a 0.001-0.003 inch axial interference. It was found that the tolerances on thickness and parallelism of the P/N 592069 laminated shim could produce a widely varying clamping force with a resulting poor distribution across the P/N 592067 retaining plate. The redesign supersedes the laminated shim with a P/N SK94932 solid shim. The solid shim has a thickness tolerance of 0.0005 inches vs. 0.002 inches for the laminated shim. In addition, the original design housing liner tolerance on parallel surfaces of 0.001 inch was reduced to 0.0005 inch. These closer tolerances result in a clamping force of more uniform distribution without exceeding the stress limit of the retaining plate. The second design change was made on the basis that normal propeller moment loading of the barrel tailshaft could cause small radial displacements of the preloaded bearing cartridge. The redesign reduced the permissible surface finish of the liner shoulder from 125 micro-inch to 32 micro-inch and incorporated flash silver plating at that location. The plating is intended to prevent wearing of the liner shoulder and thus maintain the desired clamping force.

Seal Sleeve - P/N 592041

The sleeve had a band of wear similar to the P/N 592014-2 barrel tailshaft from contact with its corresponding P/N 582555-5 shaft seal. The wear depth was superficial and was removed by lapping without significantly reducing the thickness of the chrome surface coating. See Figure 13 for typical appearance - Figure 4, the Gear Reduction - L.H. subassembly drawing,for orientation of the sleeve on the propeller barrel tailshaft.

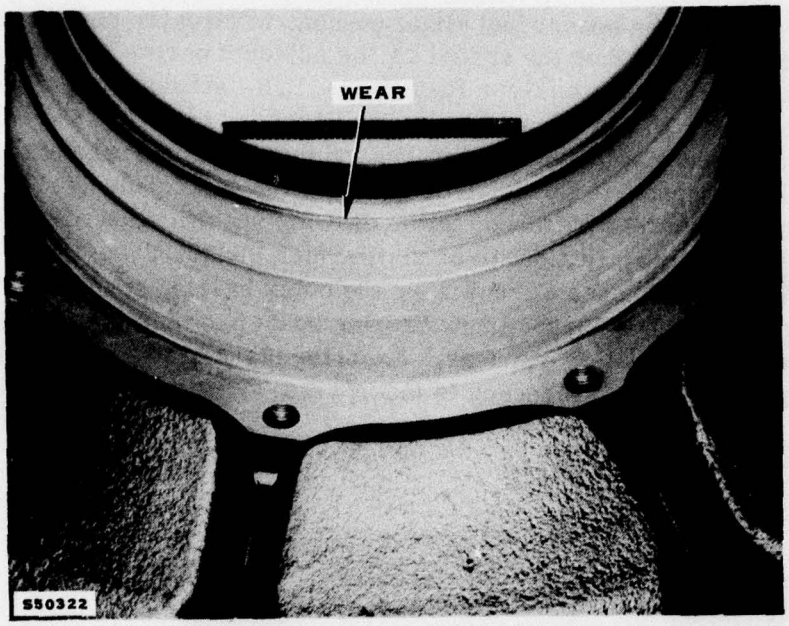


Figure 12. Front Housing Bearing Liner

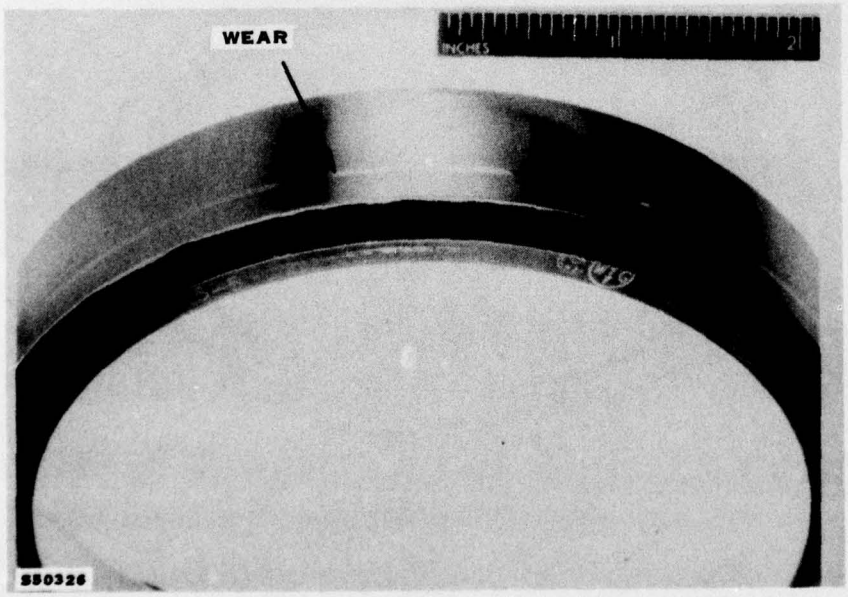


Figure 13. Seal Sleeve

Outer Bearing Spacer - P/N 592044

The parallel end faces of the spacer had slight concentric circular ring wear patterns which indicated rotation of either the spacer or the adjacent parts. See Figure 14 for typical appearance - Figure 4, the Gear Reduction - L.H. subassembly drawing, for orientation of the spacer within the assembly. This spacer is part of the bearing cartridge stack-up discussed under P/N 592048 and the design changes are expected to prevent rotation of the spacer. Corrective action for the spacer involved grinding the end faces, to remove the wear patterns, to the drawing specification of surface finish and parallelism and incorporation of silver plating (per HS519, Type 1, Grade B) to prevent wear. As a consequence of reworking the outer bearing spacer it was also necessary to regrind the P/N 592038 inner bearing spacer to maintain the required preload on the two tapered roller bearings. Experimental engineering change E121785, dated 18 November 1977, was processed to incorporate silver plate in all future parts.

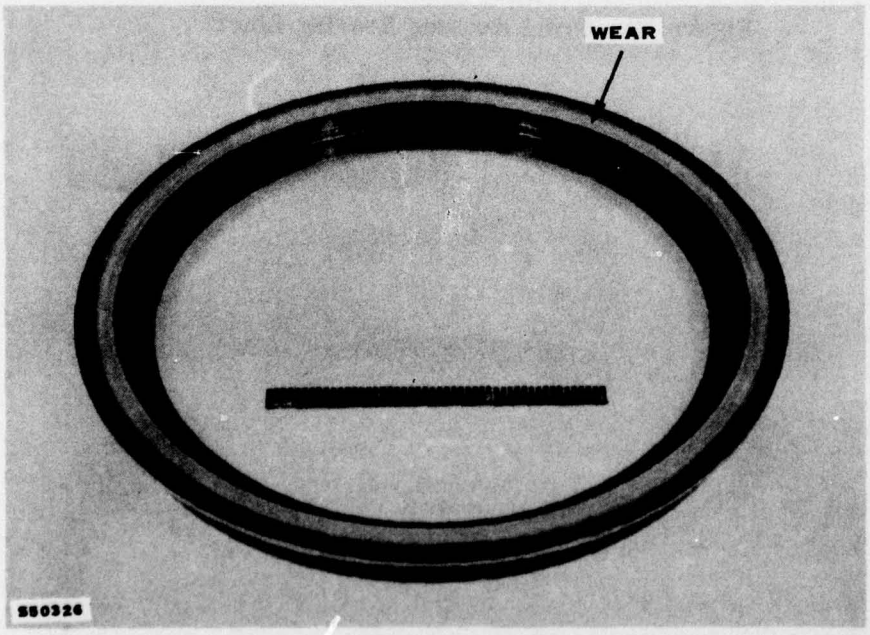


Figure 14. Outer Bearing Spacer

Torque Bracket - P/N 592208

The bracket tang had a chafed condition of no significant depth on the surface that restrains the P/N 592061 transfer housing. However, as a consequence of the corrective action to the transfer housing, which will be discussed later, the bracket was silver plated (per HS 519, Type 1, Grade B) over the contact surfaces in accordance with experimental engineering change E121785, dated 18 November 1977. See Figure 1, the Gear Reduction and Propeller assembly drawing, for orientation of the bracket at the rear of the gear reduction housing.

Seal Retaining Ring - P/N 592083

The ring was scored and worn on the inside diameter due to the tumbling action of a dog point that had separated from a failed P/N 592078 special bolt which will be discussed later. See Figure 15 for documentation of the distress and Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the ring in the assembly. No evidence of cracks or deformation were present. Although the ring was considered structurally and functionally acceptable, a replacement ring, which was obtained from the Calspan spares, was used for improved appearance.

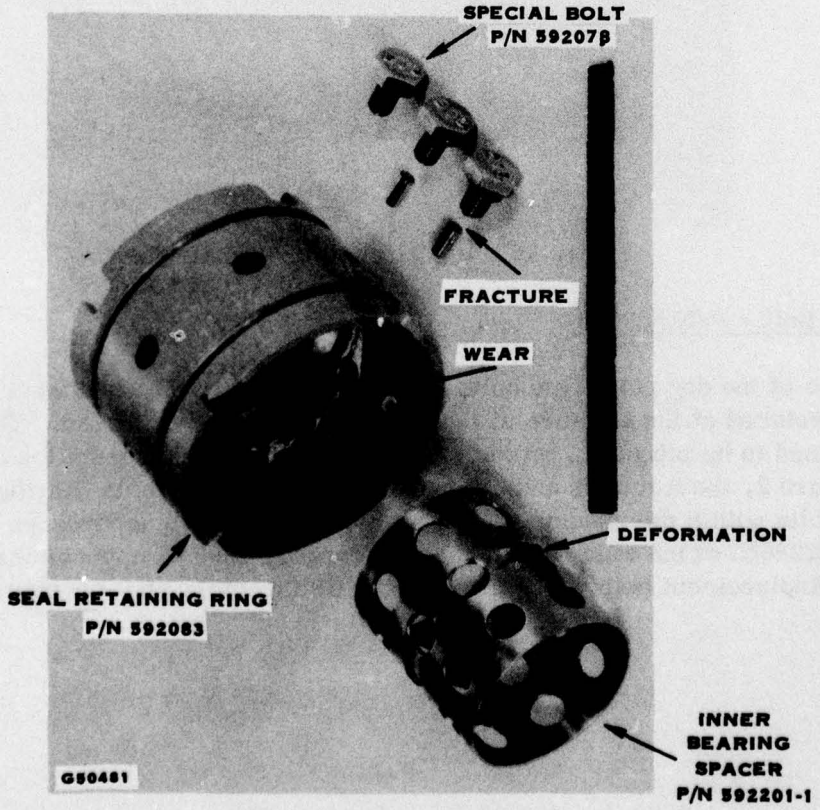


Figure 15.

Rotating Fluid Transfer Sleeve - P/N 592074

Two sleeves are employed in each assembly and both had slight bands of concentric circular wear rings on their sealing faces. See Figure 16 for typical appearance - Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the two sleeves in the assembly. In order not to compromise the sealing effectiveness of new mating P/N 592080 face seals, the end sealing faces were relapped to drawing specification of three helium light bands maximum for flatness.

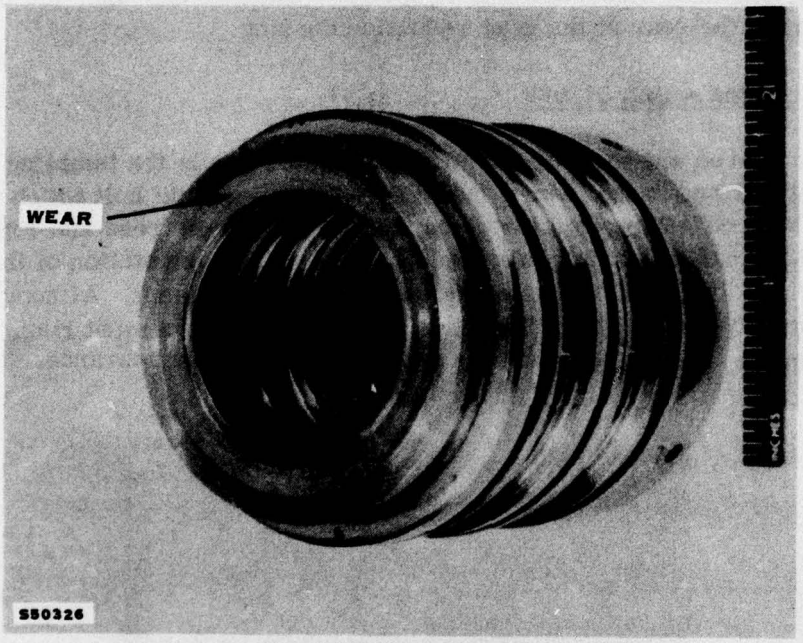


Figure 16. Rotating Fluid Transfer Sleeve

Special Bolt - P/N 592078

All three of the dog point type bolts that restrain the P/N 592083 seal retaining ring were fractured at the juncture of the dog point and the bolt thread. The fracture was determined to be fatigue in nature. See Figure 15 for documentation of the fractures and Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the bolts within the assembly. These bolts were not in accordance with experimental change E28635 which was published on 2 February 1968 to improve the strength in this area. Replacement bolts were drawn from HS inventory and incorporated at reassembly.

Transfer Housing - P/N 592061

The anti-rotation slot in the aluminum housing showed significant wear. See Figure 17 for typical appearance - Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the housing at the aft end of the assembly. This wear was similar to that revealed by three housings for which a repair was developed when sent to HS in 1975. The repair procedure, which involved incorporation of a steel-dovetail-insert that is bonded and pinned, was repeated for this housing.

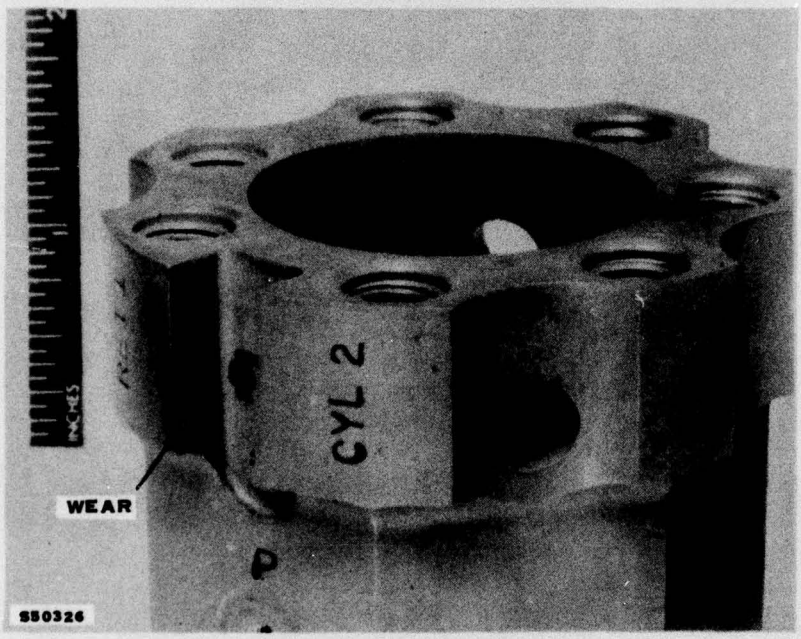


Figure 17. Housing Anti-Rotation Slot

Inner Bearing Spacer - P/N 592201-1

The spacer was deformed from the tumbling action of the fractured dog point discussed earlier. See Figure 15 for documentation of the deformation and Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the spacer in the assembly. A replacement spacer was obtained from the Calspan spares and incorporated at reassembly.

Afterbody - P/N 592251

The afterbody, normally a two piece construction, was fractured into multiple pieces. See Figure 18 for documentation of the fractures and Figure 1, the Gear Reduction and Propeller assembly drawing, for orientation of the afterbody on the propeller. No information was available as to the incident causing the fractures. A replacement afterbody was obtained from the Calspan spares and incorporated at reassembly.

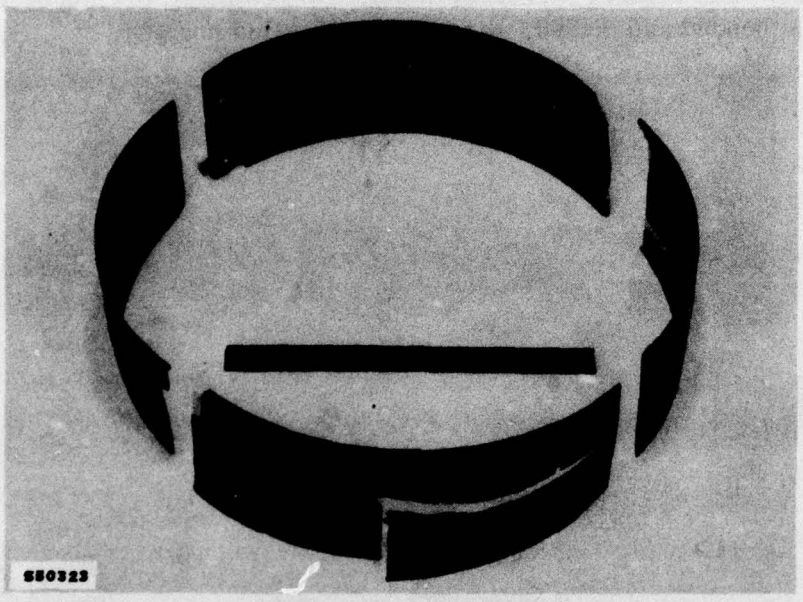


Figure 18. Afterbody

Bleed Screw - P/N 583155

The four needle pointed screws were heavily grooved and the bleed orifice diameters distorted from contact with their mating P/N 582570 bleed screw extensions. The wrenching hexagons were rounded from apparent overtorque. See Figure 19 for documentation of the damage and Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the four screws at the front of the assembly. Observation of a specified installation torque of 15-20 inch pounds should prevent a re-occurrance of this problem. New screws were manufactured and incorporated at reassembly. During remanufacture a tolerance condition was discovered which could place the bleed hole in close proximity to the conical sealing seat causing the potential for leakage. Experimental engineering change E121802 was published on 9 January 1978 to eliminate the possibility of this occuring in these and future parts.

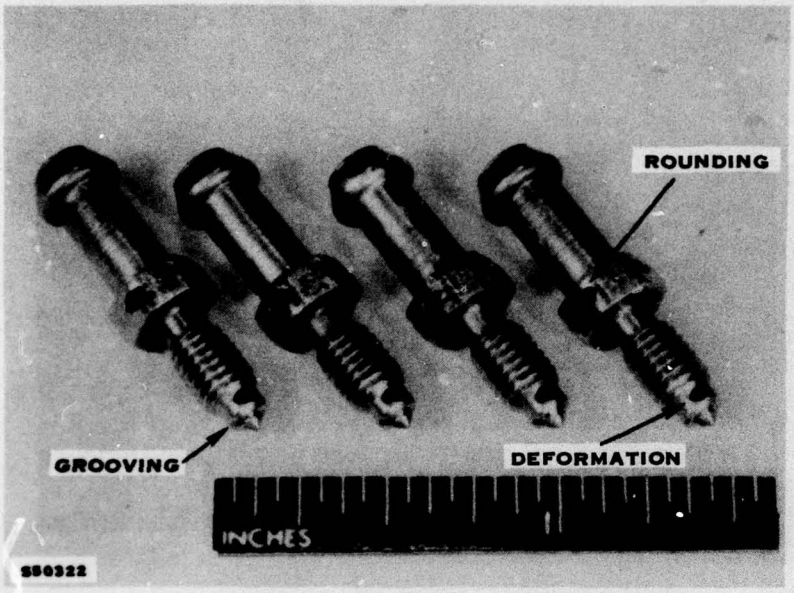


Figure 19. Bleed Screws

Blade Trunnion - P/N 592011

The outside diameter of the trunnion incorporates two lands, one on either side of a seal groove, which control the radial position of the trunnion within the P/N 592006 propeller blade shank. The inboard land, which is directly exposed to the propeller operating fluid, was free of chafing while the outboard land which cannot be lubricated, was slightly chafed. See Figure 20 for typical condition - Figure 1, the Gear Reduction and Propeller assembly drawing, for orientation of the trunnion within the propeller blade. The bore of each propeller blade was also slightly chafed from contact with the trunnion. On the basis that only one land is required for the positioning function, the outboard land diameter was reduced from 3.9398-3.9402 to 3.936-3.938 inch by experimental engineering change E121785, dated 18 November 1977, to prevent contact with the blade shank bore. The slight chafing in the blade shank bore was polished prior to reassembly.

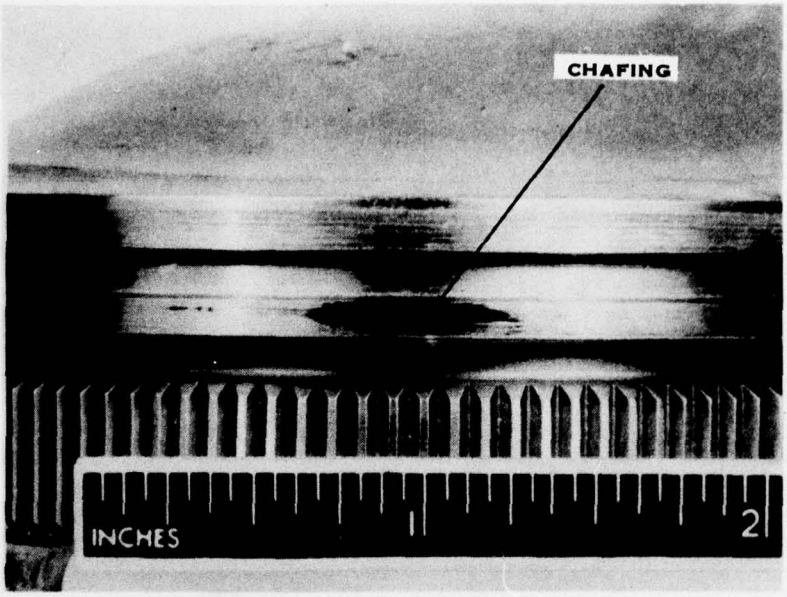


Figure 20. Trunnion Lands

Piston Rod Support - P/N 592088

Evidence of chafing was present on the outside diameter of the support from contact with the interfacing P/N 592014-2 propeller barrel bore. See Figure 21 for typical appearance - Figures 1 and 2, the Gear Reduction and Propeller and Actuator and Transfer Bearing, assembly and subassembly drawings, for orientation of the support within the propeller barrel. This condition suggested that the oil level in the propeller barrel was not adequate to cover the interfacing surfaces. The propeller barrel bore was polished and the outside diameter of the support was reworked to 3.6205 inch minimum and then electrofilmed (per HS 248, Class 40, Type A2). An experimental engineering change E121785, dated 18 November 1977, was published to incorporate the electrofilm in all future parts.

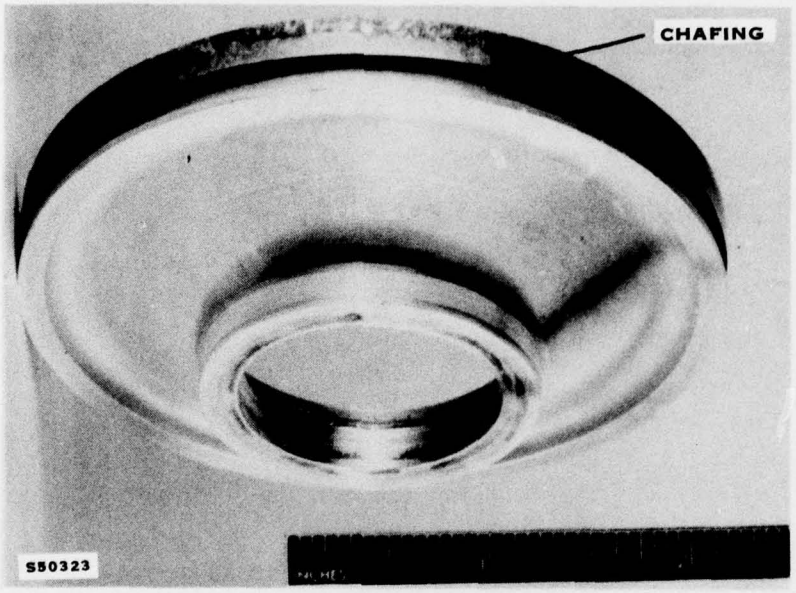


Figure 21. Piston Rod Support

Spinner - P/N 592250-1

Spinner mounting is accomplished by means of nine steel Rosan type studs threaded and locked into aluminum bushings which in turn are bonded into the fiberglass spinner. See Figure 1, the Gear Reduction and Propeller assembly drawing, for orientation of the spinner in the assembly. Dye check inspection revealed a crack indication in one of nine bushings. The defective bushing was replaced.

Piston Rod - P/N 592094

The rod incorporates a buttress type thread which was galled from contact with the interfacing P/N 583150 retaining nut. See Figure 22 for typical appearance - Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the rod within the assembly. The thread was reworked to the low limit of drawing specification to remove the majority of the galling and a light coating of a special high temperature anti-seize lubricant known as Silver Goop applied prior to reinstalling the retaining nut. This current technology coating is in use on the HS F-16 Environmental Control System and is obtainable from the Crawford Fitting Company of Cleveland, Ohio.

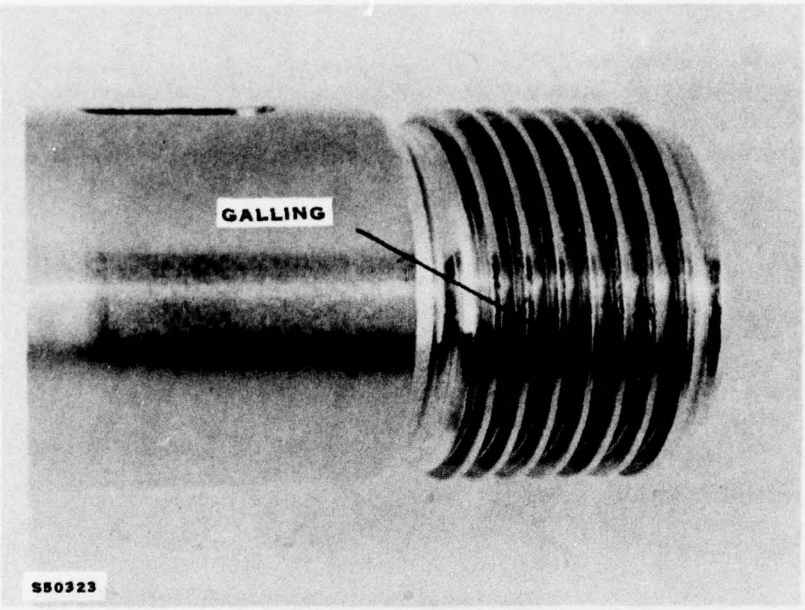


Figure 22. Rod Buttress Thread

Bulkhead Retaining Nut - P/N 583150

The nut was galled from contact with the P/N 592094 rod as reported above. See Figure 23 for documentation of the galling - Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the nut within the assembly. The thread was reworked to the low limit of drawing specification to remove the majority of the galling indications and electrofilmed (per HS 248, Class 42, Type A1). Experimental engineering change E121785, dated 18 November 1977, was processed to incorporate the electrofilm in all future parts.

Propeller Blade - P/N 592006

The three blades, S/N's 779333, 779334, 777335, exhibited a variety of minor non-structural damage as shown in Table 6. See Figures 1 and 5, the Gear Reduction and Propeller and Blade assembly drawings, for orientation of the blade in the assembly. The blades were refurbished, as required, using standard procedures currently in use at HS.

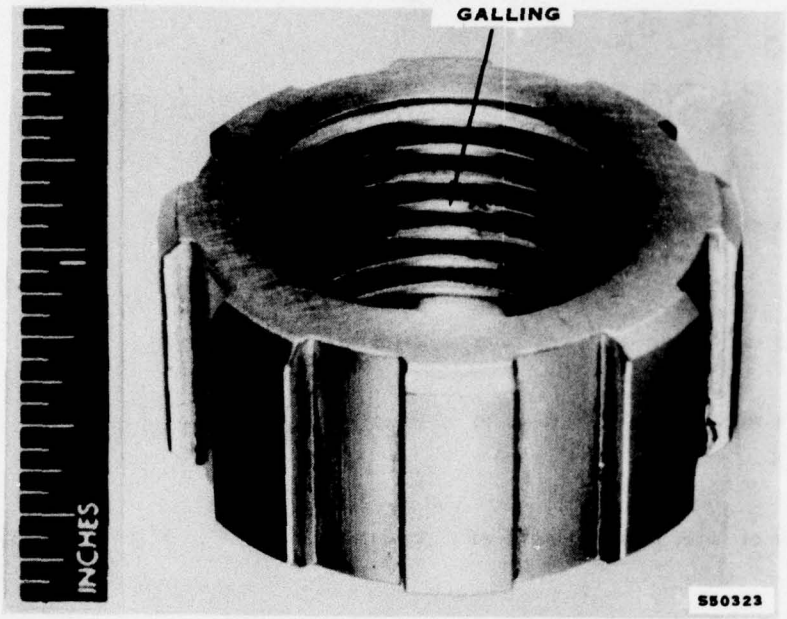


Figure 23. Bulkhead Retaining Nut

TABLE 6. PROPELLER BLADE INSPECTION SUMMARY

Propeller Assembly S/N	Blade Spar Heat S/N	Code	Shank Magnaflux	Shank Dimensional	Shank - Visual O.D.	Shank - Visual I.D.	Tap Test	X-Ray	Pressure Test	Visual Spar Foam	Visual Blade Airfoil
222418	779333		0	0	1	2	0	0	0	0	0
	779334		0	0	1	2	3	6	0	0	4
	779335		0	0	1	2	3	0	0	0	4
222411	777336		0	0	0	2	3	0	0	0	0
	777337		0	0	1	2	3	0	0	0	4
	777338		0	0	0	2	0	0	0	0	4
222417	777142		0	0	1	2	0	0	0	0	0
	777143		0	0	1	2	3	6,7	0	0	4,6
	777144		0	0	1	2	3	6	0	0	4
222414	777145		0	0	1	2	3	0	0	0	4,5
	777146		0	0	2	2	3	0	0	0	4
	777147		0	0	2	2	3	6	0	0	4

CODE:
- 0 - No abnormal condition
- 1 - Surface staining
- 2 - Surface scratches
- 3 - Fiberglass cuff delaminations
- 4 - Foreign object damage
- 5 - Erosion coating surface cracks
- 6 - Sheath tip cracks
- 7 - Cuff foam crack

During blade refurbishing, several field type repairs were discovered in the cuff area after erosion coating had been removed in local areas. These field repairs were found to be in good condition; however, all were removed and replaced because the type of repair material was unknown. The HS process specification for fiberglass blades, HS 2168, defines ZZL-0830/0845 as the hardner for Epon 828 resin to be used in repairing fiberglass damage. The resin manufacturer has discontinued this material and now supplies ZZL 0840 as the substitute. The following mixture ratios were therefore used in place of those specified in HS 2168:

Epon 828 50.5 Parts by Weight

Butyl Glycidyl Ether 5.1 Parts by Weight

ZZL 0840 7.4 Parts by Weight

Valve Sleeve - P/N 720786-1

The sleeve bore was chafed where it contacts the interfacing P/N 720784-1 piston. See Figure 10, the Converter subassembly drawing, for orientation of the sleeve and piston in the assembly. The sleeve bore was reworked to remove the chafing and the piston chrome plated (per HS 246) to restore the fit required in the assembled valve. It must be noted that as a result of this rework these particular parts are no longer interchangeable with the same parts in other assemblies - in effect these parts are a matched set.

Miscellaneous Parts

Nicks and scratches were present on the external surfaces of various non-ferrous parts. Corrective action for anodized aluminum parts was alodine touch-up (per HS 240, Code I) while for magnesium parts it was chrome pickle (per HS 453 Type I).

Gear Reduction and Propeller Assembly

P/N 131GB8-1, S/N 222411

This assembly had been removed from the right-forward-position, number one aircraft, in August of 1966 after having accumulated 35.8 operating hours. This area of the aircraft was reported to be undamaged by the incident.

Disassembly of this unit revealed the preservation and storage techniques to be adequate and the general condition of the detail parts to be satisfactory. Magnetic particle and/or fluorescent penetrant inspection of metal parts did not reveal any distress. However, a dye check of the molded in place aluminum inserts in the fiberglass spinner showed indications in one of nine inserts. X-ray inspection of the blades did not reveal any abnormalities.

Gear Reduction and Propeller Assembly (continued)

Twenty-nine detail parts and one subassembly involving 32 additional parts were missing, 18 were unsatisfactory and two parts were not in accordance with required engineering changes which were generated after BAC took custody of the assembly. Table 7 delineates the status of the above detail parts and subassembly. Again, expendable items such as seals were excluded from the listing. All but eight of the missing parts were obtainable from HS and Calspan spare part inventories or from the four residual assemblies. A replacement for one of the two parts not in accordance with required engineering changes was obtained from HS spare part inventory while the second part required remanufacture. The replacement for the superseded Converter subassembly was obtained from the number two aircraft. However, this subassembly contained three parts that exhibited wear. Thus, the total of unsatisfactory parts became 21. As cited earlier, replacements for missing parts were obtained by remanufacture.

TABLE 7. PART INSPECTION - DISPOSITION SUMMARY

131GB8-1 S/N 222411

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592102	Hydraulic Tube	1	Missing	Remanufacture
592103	Hydraulic Tube	1	Missing	Remanufacture
592104	Hydraulic Tube	1	Missing	Remanufacture
592105	Hydraulic Tube	1	Missing	Remanufacture
592106	Hydraulic Tube	1	Missing	Remanufacture
592107	Hydraulic Tube	1	Missing	Remanufacture
MS21921-4C	Flareless Nut	12	Missing	Replace from inventory
MS21922-4	Flareless Sleeve	12	Missing	Replace from inventory
592251	Afterbody	1	Missing	Replace from residual assys.
592119-1	Eyebolt and Bearing	1	Missing	Replace from residual assys.
592119-2	Eyebolt and Bearing	1	Missing	Replace from residual assys.
NAS509L6	Jam Nut	1	Missing	Replace from residual assys.
592132	Body	1	Missing	Replace from residual assys.
NAS1193-6C	Locking Device	1	Missing	Replace from residual assys.
NAS509-6	Jam Nut	2	Missing	Replace from residual assys.
537458-5	Rod End Bearing	1	Missing	Replace from residual assys.
592137	Potentiometer	1	Missing	Replace from inventory
582400A6	Laminated Shim	2	Missing	Replace from inventory
592060-1	Lube Pump	1	Missing	Replace from residual assys.
592068	Drive Gear	1	Missing	Replace from residual assys.
514287	Retaining Nut	1	Missing	Replace from residual assys.
514288	Lock Ring	1	Missing	Replace from residual assys.
592008-1	Converter Assembly	32 parts in Assy.	Missing	Superseded by 726600-1 and end assembly reidentified as 131GB8-3.

TABLE 7. PART INSPECTION - DISPOSITION SUMMARY (Continued)

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592082	Check Valve	1	Missing	Remanufacture
553888	Special Washer	9	Missing	Remanufacture
69863-31	Locking Nut	9	Missing	Replace from inventory
582400A14	Laminated Shim	2	Missing	Replace from inventory
MS20364-1032A	Lock Nut	1	Missing	Replace from inventory
AN320-4	Nut	2	Missing	Replace from inventory
592131-4-10	Special Bolt	1	Missing	Replace from inventory
592014-1	Propeller Barrel	1	Galled	Replace from residual assys.
582526	Retaining Nut	1	Galled	Replace from residual assys.
592089	Feedback Shaft	1	Not in accordance with required change.	Remanufacture
592157	Connecting Link	1	Worn	Rework
592078	Special Bolt	9	Not in accordance with required change.	Replace from inventory
592250	Spinner	1	Damaged	Rework
592005	Propeller Blade	3	Damaged	Rework
592133	Guide	1	Worn	Replace from inventory
720777	Housing	1	Worn	Rework
720768	Housing	1	Worn	Rework
592047	Front Housing	1	Worn	Repair
592041	Seal Sleeve	1	Worn	Rework
592044	Bearing Spacer	1	Worn	Rework
583155	Bleed Screw	4	Worn	Remanufacture
577049H15	Flat Washer	1	Worn	Replace from inventory
592074	Rotating Sleeve	2	Worn	Rework
592061	Transfer Housing	1	Worn	Repair

TABLE 7. PART INSPECTION - DISPOSITION SUMMARY (Continued)

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592208	Torque Bracket	1	Chafed	Rework
69445A3	Identification Plate	1	Damaged	Replace from inventory
592011	Blade Trunnion	3	Chafed	Rework
592088	Piston Rod Support	1	Chafed	Rework
592094	Piston Rod	1	Galled	Rework
583150	Retaining Nut	1	Galled	Rework

Following is a general description of the discrepant parts listed in Table 7.

Propeller Barrel - R.H. - P/N 592014-1

The barrel tailshaft external buttress type thread was severely galled. See Figure 24 for documentation of the galling and Figure 3, the Gear Reduction - R.H. subassembly drawing, for orientation of the barrel within the assembly. This damage appeared to be due to pickup of foreign material during the previous installation of the interfacing P/N 582526 retaining nut. A replacement barrel was obtained from the four residual assemblies and a light coating of the anti-seize lubricant called Silver Goop was applied to the threads at reassembly. Experimental engineering change E-21785, dated 12 November 1977, was processed to incorporate the lubricant.

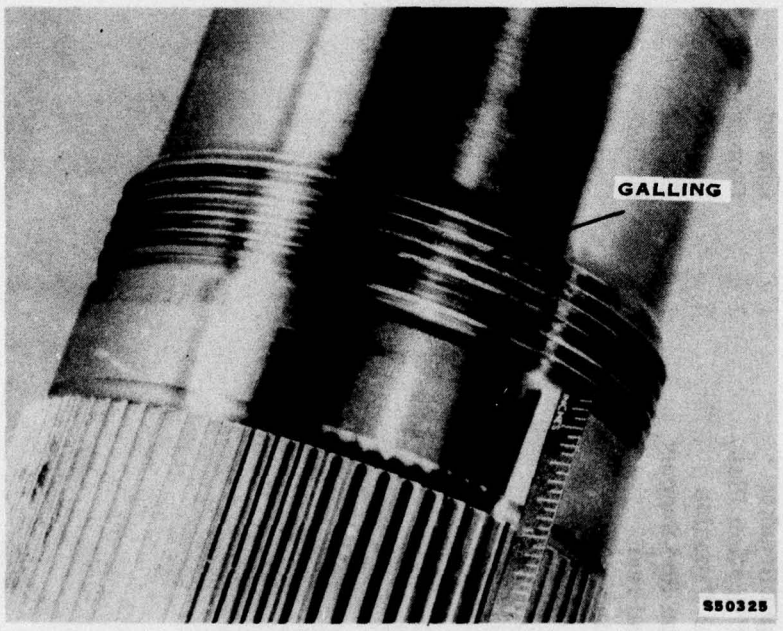


Figure 24. Barrel Buttress Thread

Retaining Nut - P/N 582526

The nut internal buttress type thread was severely galled from contact with the P/N 592014-1 barrel, as reported above. See Figure 25 for documentation of the galling and Figure 3, the Gear Reduction - R.H. subassembly drawing, for orientation of the nut on the barrel. A replacement nut was obtained from the four residual assemblies and electrofilmed (per HS 248, Class 42, Type A1). Experimental engineering change E121785, dated 18 November 1977, requires electrofilming of all future parts.

Figure 25. Retaining Nut

Feedback Rod - P/N 592089

The rod was not to the latest required configuration. A replacement rod was thus manufactured in accordance with experimental engineering change E28633, dated 11 December 1967.

Rigid Connecting Link - P/N 592157

The link showed wear where it contacted the interfacing P/N 592075 bearing housing. See Figure 26 for documentation of the wear and Figure 1, the Gear Reduction and Propeller assembly drawing, for orientation of the link in the assembly. Unauthorized teflon washers were found between the link and the two P/N 592075 bearing housing arms. The wear was attributed to a collection of abrasive material between the washers and the link. Because the other assemblies, without the washers, did not exhibit wear and no documentation substantiating installation of washers was found, the link was reinstalled without washers after polishing and alodining (per HS 240, Code 1).

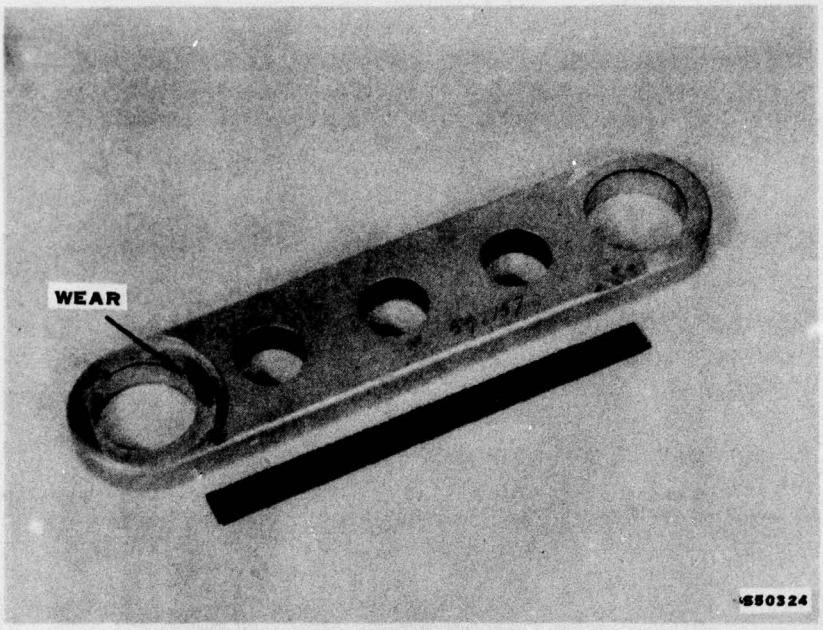


Figure 26. Rigid Connecting Link

Special Bolt - P/N 592078

The three bolts were not to the latest required configuration. Replacement bolts were drawn from HS spare part inventory and incorporated at reassembly.

Spinner - P/N 592250-1

The spinner exhibited the same conditions as those reported for Gear Reduction and Propeller assembly S/N 222418 except two separate indications were detected in one bushing. The defective bushing was replaced.

Converter Guide - P/N 592133

The hardened steel guide was worn at each end from sliding contact with hardcoated longitudinal slots in its interfacing P/N 720777 aluminum housing. See Figure 27 for documentation of the wear and Figure 10, the Converter subassembly drawing, for orientation of the guide within the assembly. A replacement guide was drawn from Calspan spare part inventory and incorporated at reassembly.

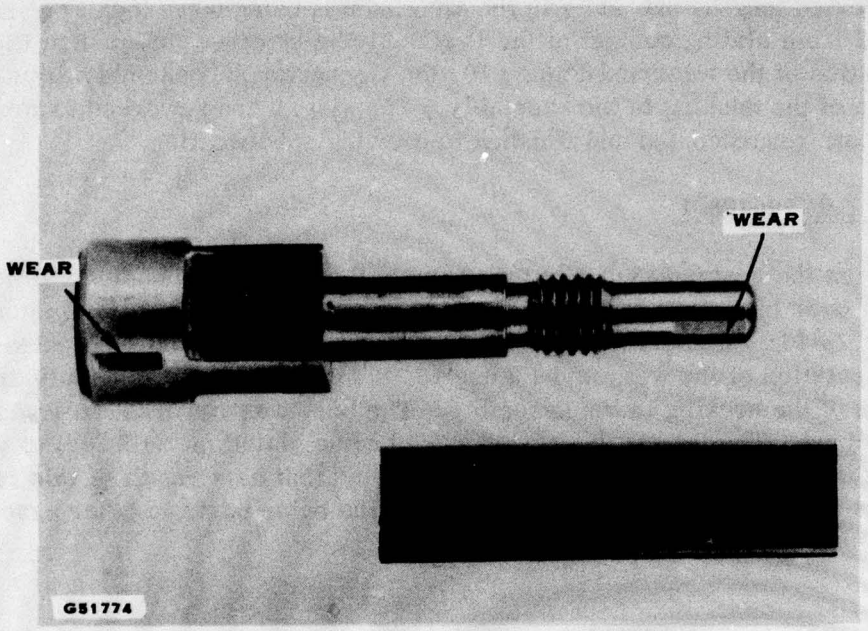


Figure 27. Converter Guide

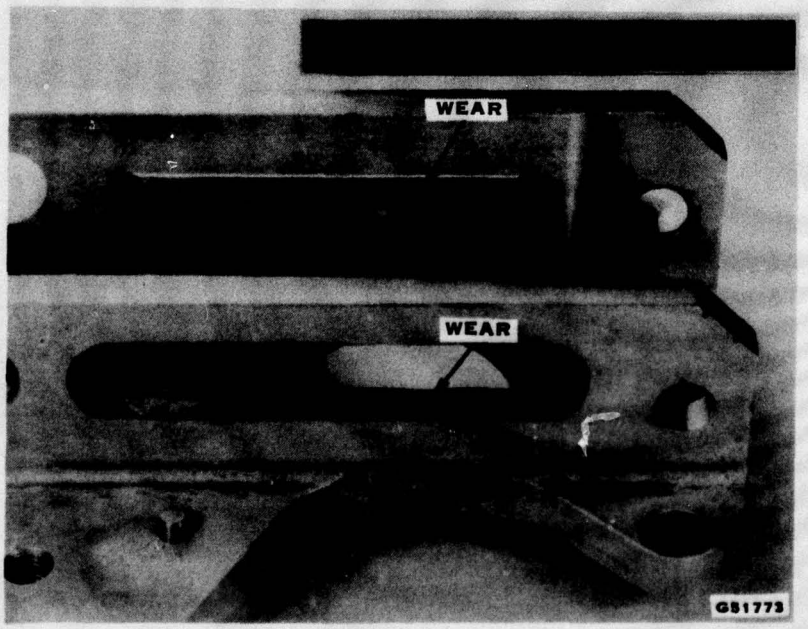


Figure 28. Housing Slots

Housing - P/N 720777-1

The hardcoated longitudinal slots in the aluminum housing were locally worn to the base metal from sliding contact of the P/N 592133 converter guide. See Figure 28 for documentation of the wear and Figure 10, the Converter subassembly drawing, for orientation of the housing in the assembly. The slots were reworked to remove residual hardcoat, rehardcoated and finished to drawing specification.

Housing - P/N 720768-1

The anodized internal 0.938-0.039 inch bore in the aluminum housing was locally worn 0.006 inch over high limit from sliding contact with the P/N 720778-1 piston and its P/N MS28775-018 / P/N 719955-3 preformed packing/outer seal ring. See Figure 29 for documentation of the wear and Figure 10, the Converter subassembly drawing, for orientation of the housing in the assembly. The bore was reworked to remove the wear and reanodized. The interfacing piston was chrome plated (per HS 246) to restore the fit required in the end assembly. It must be noted that as a result of this rework, these parts are no longer interchangeable with the same parts in other assemblies - in effect this set of parts is a matched set.

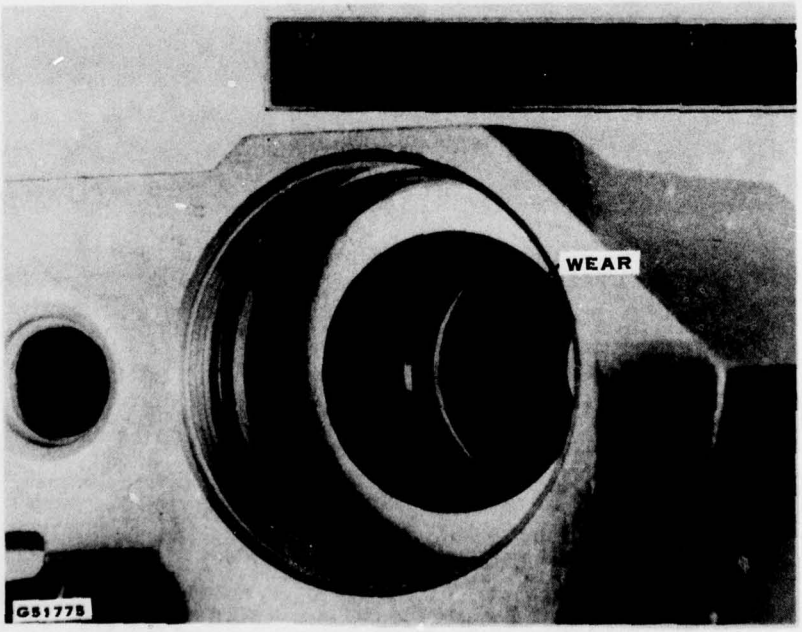


Figure 29. Housing Bore

The following parts exhibited conditions typical of those revealed for Gear Reduction and Propeller Assembly S/N 222418 and the material disposition was duplicated:

Propeller Blade - P/N 592005

Opposite hand rotation of P/N 592006

Housing and Inserts - P/N 592047

Opposite hand rotation of P/N 592048

Seal Sleeve - P/N 592041

Outer Bearing Spacer - P/N 592044

Bleed Screw - P/N 583155

Rotating Fluid Transfer Sleeve - P/N 592074

Transfer Housing - P/N 592061

Torque Bracket - P/N 592208

Blade Trunnion - P/N 592011

Piston Rod Support - P/N 592088

Piston Rod - P/N 592094

Bulkhead Retaining Nut - P/N 583150

Miscellaneous Parts

Nicks and scratches were present on the external surfaces of various non-ferrous parts similar to that shown by Gear Reduction and Propeller assembly S/N 222418 and the disposition of material was identical.

Gear Reduction and Propeller Assembly

131GB9-2, S/N 222417

The third assembly to be examined had been removed from the right-aft-position, number two aircraft, in June 1974 after accumulating 201.1 operating hours.

The preservation and storage of this assembly was found to be satisfactory. The general condition of the detail parts was also satisfactory but cannibalization was extensive. Magnetic particle and/or fluorescent penetrant inspection showed the metal parts to be free of indications. However, a dye check of the molded in place aluminum inserts in the fiberglass spinner, showed indications in one of nine inserts. X-ray inspection revealed minor nonstructural sheath tip cracks in two blades and a cuff foam crack in one blade.

Seventeen detail parts and three subassemblies, consisting of an additional 122 parts, were missing and 12 were unsatisfactory. Table 8 delineates the status of each of the above detail parts and subassemblies. The pool of detail parts and subassemblies from the four residual assemblies and the Calspan and HS spare part inventories reduced the shortage to nine detail parts for this unit. The replacement for the superseded converter subassembly was obtained from the number two aircraft. However, this subassembly contained one additionally worn part. The total of unsatisfactory parts for this assembly became 13. Replacements for the nine missing parts were obtained by remanufacture.

TABLE 8. PART INSPECTION - DISPOSITION SUMMARY

131GB9-2 S/N 222417

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592102	Hydraulic Tube	1	Missing	Remanufacture
592103	Hydraulic Tube	1	Missing	Remanufacture
592104	Hydraulic Tube	1	Missing	Remanufacture
592105	Hydraulic Tube	1	Missing	Remanufacture
592106	Hydraulic Tube	1	Missing	Remanufacture
592107	Hydraulic Tube	1	Missing	Remanufacture
MS21921-4C	Flareless Nut	12	Missing	Replace from inventory
MS21922-4	Flareless Sleeve	12	Missing	Replace from inventory
592250	Spinner and Bulkhead	9 parts	Missing	Replace from residual assys.
592251	Afterbody	1	Missing	Replace from residual assys.
592062	Transfer Tube	1	Missing	Replace from residual assys.
592000	Actuator and Transfer Bearing Assembly	81 parts in Assy.	Missing	Replace from residual assys.
592015	Chip Detector	2	Missing	Replace from inventory
592057-2	Pin	1	Missing	Replace from inventory
NAS1272H4	Bolt	12	Missing	Replace from inventory
592003-2	Flat Washer	12	Missing	Replace from inventory
592082	Check Valve	1	Missing	Remanufacture
592157	Connecting Link	1	Missing	Replace from residual assys.
592008-2	Converter Assembly	32 parts in Assy.	Missing	Superseded by 726600-2 and end assembly reidentified as 131GB9-4
553888	Special Washer	9	Missing	Remanufacture
592014-2	Propeller Barrel	1	Worn	Rework

TABLE 8. PART INSPECTION - DISPOSITION SUMMARY (Continued)

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
MS9015-08	Drain Plug	1	Worn	Replace from inventory
69445A3	Identification Plate	1	Damaged	Replace from inventory
592041	Seal Sleeve	1	Worn	Rework
592208	Torque Bracket	1	Chafed	Rework
592048	Front Housing	1	Worn	Repair
592044	Bearing Spacer	1	Worn	Rework
583155	Bleed Screw	4	Worn	Remanufacture
592011	Blade Trunnion	3	Chafed	Rework
592088	Piston Rod Support	1	Chafed	Rework
592250	Spinner	1	Damaged	Rework
592006	Propeller Blade	3	Damaged	Rework
720777	Housing	1	Worn	Rework

Following is a general description of the discrepant parts listed in Table 8.

Propeller Barrel - L.H. - P/N 592014-2

The barrel tailshaft exhibited a band of wear of moderate depth from contact with its corresponding P/N 582555-2 shaft seal. See Figure 4, the Gear Reduction - L.H. subassembly drawing, for orientation of the barrel and seal in the assembly. The tailshaft was reworked to remove the band, replated and refinished to restore surface finish and size.

Seal Sleeve - P/N 592041

The sleeve exhibited a band of wear of moderate depth from contact with its corresponding P/N 582555-5 shaft seal. See Figure 4, the Gear Reduction - L.H. subassembly drawing, for orientation of the sleeve on the propeller barrel tailshaft. The sleeve was reworked to remove the band, replated and refinished to restore surface finish and size.

The following parts exhibited conditions typical of those revealed for Gear Reduction and Propeller Assembly S/N 222418 and the disposition of material was identical.

Torque Bracket - P/N 592208

Housing and Inserts - P/N 592048

Outer Bearing Spacer - P/N 592044

Bleed Screw - P/N 583155

Blade Trunnion - P/N 592011

Piston Rod Support - P/N 592088

Spinner - P/N 592250

Propeller Blade - P/N 592006

The following part exhibited the condition revealed for Gear Reduction and Propeller assembly S/N 222411 and the disposition of material was identical.

Housing - P/N 720777

Miscellaneous Parts

Nicks and scratches were present on the external surfaces of various non-ferrous parts similar to that shown by Gear Reduction and Propeller assembly S/N 222418 and the disposition of material was identical.

Gear Reduction and Propeller Assembly

131GB8-1, S/N 222414

The fourth assembly to be examined had been removed from the left-aft-position, number two aircraft, in December 1975 after accumulating 211.2 operating hours.

The preservation and storage of this assembly was found to be satisfactory, as was the general condition of the detail parts, but as in the case of S/N 222417, cannibalization was extensive. Magnetic particle and/or fluorescent penetrant inspection showed the metal parts to be free of indications. Dye check of the molded in place aluminum inserts in the fiberglass spinner was also negative. X-ray inspection revealed the presence of minor nonstructural sheath tip cracks in one blade.

Forty-three detail parts and four subassemblies, involving 142 additional parts, were missing and 14 were unsatisfactory. Table 9 delineates the status of each of the above detail parts and subassemblies. The pool of detail parts and subassemblies from the four residual assemblies and the Calspan and/or HS spare part inventories reduced the shortage for this unit to eight detail parts. Replacements for these eight parts were obtained by remanufacture.

TABLE 9. PART INSPECTION - DISPOSITION SUMMARY

131GB8-1 S/N 222414

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592102	Hydraulic Tube	1	Missing	Remanufacture
592103	Hydraulic Tube	1	Missing	Remanufacture
592104	Hydraulic Tube	1	Missing	Remanufacture
592105	Hydraulic Tube	1	Missing	Remanufacture
592106	Hydraulic Tube	1	Missing	Remanufacture
592107	Hydraulic Tube	1	Missing	Remanufacture
MS21921-4C	Flareless Nut	12	Missing	Replace from inventory
MS21922-4	Flareless Sleeve	12	Missing	Replace from inventory
592251	Afterbody	1	Missing	Replace from residual assys.
592119-1	Eye Bolt and Bearing	1	Missing	Replace from residual assys.
592119-2	Eye Bolt and Bearing	1	Missing	Replace from residual assys.
NAS509L6	Jam Nut	1	Missing	Replace from residual assys.
592132	Body	1	Missing	Replace from residual assys.
NAS1193-6C	Locking Device	1	Missing	Replace from residual assys.
NAS509-6	Jam Nut	2	Missing	Replace from residual assys.
537458-5	Rod End Bearing	1	Missing	Replace from residual assys.
592137	Potentiometer	1	Missing	Replace from inventory
MS20364-1032A	Lock Nut	1	Missing	Replace from inventory
592000	Actuator and Transfer Bearing Assembly	81 parts in Assy.	Missing	Replace from residual assys.
592100	Distributor Valve Assembly	20 parts in Assy.	Missing	Replace from residual assys.
592008-1	Converter Assembly	32 parts in Assy.	Missing	Superseded by 726600-1 and end assy. reidentified as 131GB8-3
592250	Spinner Assembly	9 parts in Assy.	Missing	Replace from residual assys.
592120	Lever and Bushing	1	Missing	Replace from residual assys.

TABLE 9. PART INSPECTION - DISPOSITION SUMMARY (Continued)

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592157	Connecting Link	1	Missing	Replace from residual assys.
592125	Lever and Bushing	1	Missing	Replace from residual assys.
AN960-10L	Flat Washer	4	Missing	Replace from residual assys.
592122	Connecting Link	1	Missing	Replace from residual assys.
MS24675-25	Bolt	4	Missing	Replace from residual assys.
AN960-416	Washer	4	Missing	Replace from residual assys.
592131-4-28	Special Bolt	2	Missing	Replace from inventory
NAS620-416L	Washer	2	Missing	Replace from inventory
AN320-4	Nut	8	Missing	Replace from inventory
MS9245-28	Cotter Pin	8	Missing	Replace from inventory
592131-4-12	Special Bolt	1	Missing	Replace from inventory
592131-4-10	Special Bolt	4	Missing	Replace from inventory
592131-3-10	Special Bolt	1	Missing	Replace from inventory
NAS1291X3	Lock Nut	1	Missing	Replace from inventory
582400A14	Laminated Shim	2	Missing	Replace from inventory
592131-4-13	Special Bolt	1	Missing	Replace from inventory
592057-2	Pin	1	Missing	Replace from inventory
592003-2	Flat Washer	2	Missing	Replace from inventory
MS9015-04	Plug	1	Missing	Replace from inventory
592015	Chip Detector	1	Missing	Replace from inventory
592004-1	Special Bolt	8	Missing	Replace from inventory
582400A6	Laminated Shim	2	Missing	Replace from inventory
69863-31	Nut	9	Missing	Replace from inventory
553888	Special Washer	9	Missing	Remanufacture
592034	Rotor Drive	1	Worn	Rework
592057	Balance Plate	1	Worn	Replace from residual assys.
592089	Feedback Rod	1	Worn	Rework
720786-1	Valve Sleeve	1	Chafed	Rework
592014-1	Propeller Barrel	1	Worn	Rework

TABLE 9. PART INSPECTION - DISPOSITION SUMMARY (Continued)

Part Number	Part Name	Quantity	Disassembly Inspection	Disposition
592047	Front Housing	1	Worn	Repair
592041	Seal Sleeve	1	Worn	Rework
592044	Bearing Spacer	1	Worn	Rework
592208	Torque Bracket	1	Chafed	Rework
69445A3	Identification Plate	1	Damaged	Replace from inventory
583155	Bleed Screw	4	Worn	Remanufacture
592011	Blade Trunnion	3	Chafed	Rework
592088	Piston Rod Support	1	Chafed	Rework
592005	Propeller Blade	3	Damaged	Rework

Rotor Drive - P/N 592034

The parallel end faces of the drive had slight concentric circular ring wear patterns indicating rotation of this part. See Figure 3, the Gear Reduction - R.H. subassembly drawing, for orientation of the drive in the assembly. The end faces were reworked to low limit of specification for width to restore surface finish and parallelism.

Balance Plate - P/N 592057

The mounting face of the plate exhibited relatively severe fretting in the contact area with P/N 592014-1 propeller barrel. See Figure 30 for documentation of fretting and Figure 1, the Gear Reduction and Propeller assembly drawing, for orientation of the plate and the barrel within the assembly. The index pin, which orientates the plate to the forward barrel face, was missing and the contact pattern on the plate indicated that it had been incorrectly located on at least one occasion. A replacement plate was obtained from the four residual assemblies.

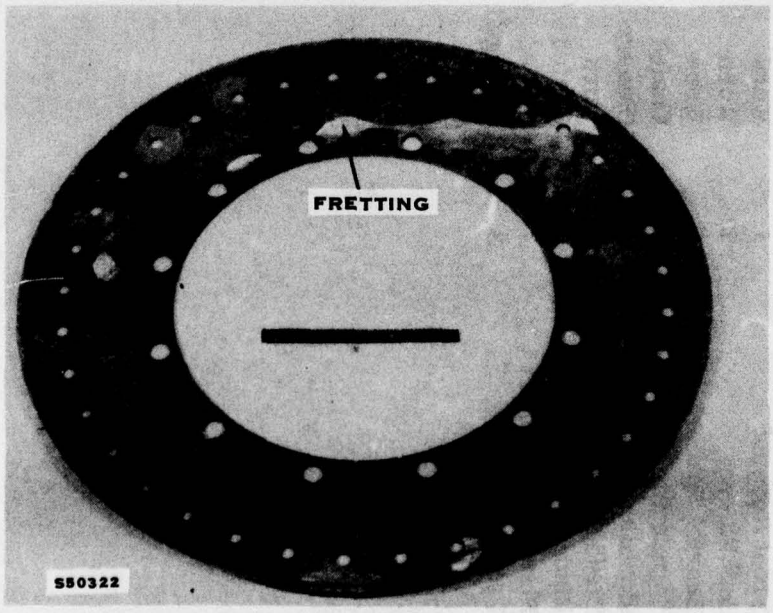


Figure 30. Balance Plate

Feedback Rod - P/N 592089

The rod exhibited a modest band of wear from contact with its interfacing P/N 592301-1 shaft seal. See Figure 31 for documentation of the wear and Figure 2, the Actuator and Transfer Bearing subassembly drawing, for orientation of the shaft in the assembly. As the wear was of sufficient depth to adversely affect sealing capability, the rod was reworked, replated and refinished to restore surface finish and size.

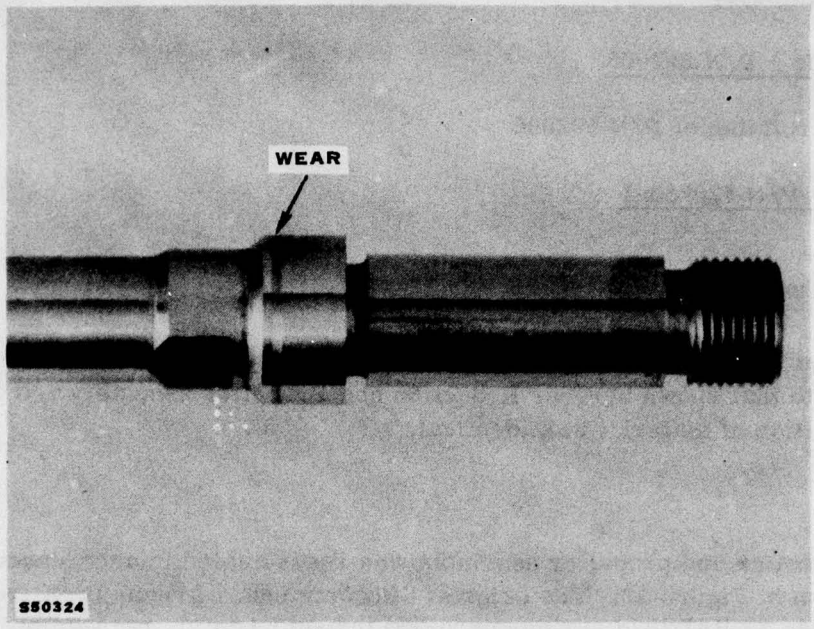


Figure 31. Feedback Rod

The following parts exhibited conditions typical of those revealed for Gear Reduction and Propeller assembly S/N 222418 and the disposition of material was identical.

Propeller Barrel - P/N 592014-1

Opposite hand rotation of P/N 592014-2

Housing and Inserts - P/N 592047

Opposite hand rotation of P/N 592048

Seal Sleeve - P/N 592041

Outer Bearing Spacer - P/N 592044

Torque Bracket - P/N 592208

Bleed Screw - P/N 583155

Blade Trunnion - P/N 592011

Piston Rod Support - P/N 592088

Parts (Continued)

Propeller Blade - P/N 592005

Opposite hand rotation of P/N 592006

Valve Sleeve - P/N 720786-1

Miscellaneous Parts

Nicks and scratches were present on the external surfaces of various non-ferrous parts similar to that shown by Gear Reduction and Propeller assembly S/N 222418 and the disposition of material was identical.

Reassembly

Each gear reduction and propeller assembly was reassembled in accordance with the sequence shown in Figure 32. The original "Recommended Assembly Instructions" (RAI), identified as RAI 2578 series, provided the guidance for reassembly and inspection. The RAI's list the individual part number, part name, installation tool number, specified installation torque (where applicable), type of lubricant to be used (where applicable), dimensional inspection steps to establish bearing preload (where applicable), and other similar measurements. It also provides a suitable log for recording actual torque and dimensional measurements. Each step in the instructions is verified with signatures of the assembler and inspector at its completion.

The only functional test performed on each assembly was pressurization of the propeller barrel oil cavity as part of the checkout procedure following final installation of The Actuator and Transfer Bearing assembly into the barrel. It was necessary to delete and/or defer all other functional tests to the aircraft as the original factory facilities are no longer in existence.

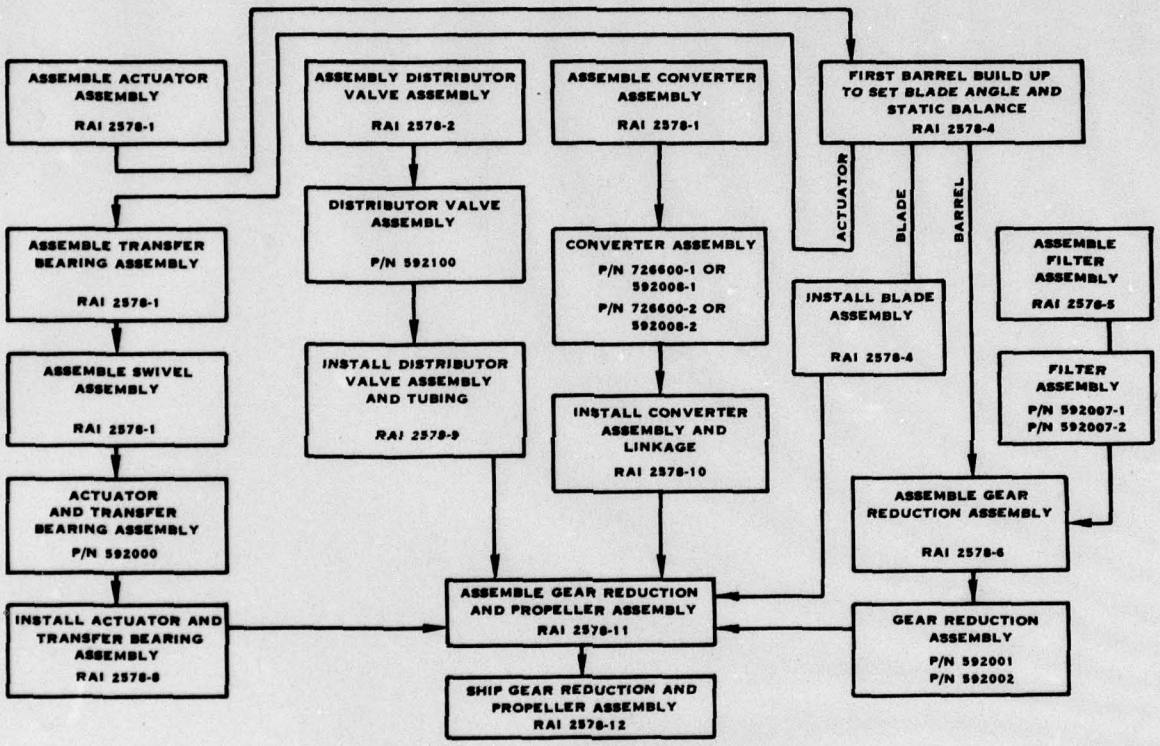


FIGURE 32. ASSEMBLY SEQUENCE

CONCLUSIONS

Based on the results of the disassembly inspection and overhaul performed on Gear Reduction and Propeller assemblies, S/N's 222411, 222414, 222417, and 222418, after operating intermittently for up to 200 hours over a period of up to 11 years, the condition of the assemblies warrants their return to service.

RECOMMENDATIONS

It is recommended that the two each, right and left hand rotation, Gear Reduction and Propeller assemblies S/N's 222411, 222414, 222417, and 222418 be returned to service, after having been installed and checked in accordance with the applicable instructions contained in Appendix B, and that these units be reinspected after 200 hours for appraisal of serviceable condition. It is further recommended that one each, right and left hand rotation, assemblies be overhauled immediately. This action would serve to minimize costly delays, in conduct of the X-22A flight research program, resulting from unscheduled propeller removals. The cost associated with the recommended effort would be held to a minimum as all the necessary support tools are now in hand and sufficient quantities of nearly all of the necessary spare parts are available. Finally, it is recommended that the residual Gear Reduction and Propeller assemblies and the Calspan and/or HS spare part inventories be maintained at HS to support the flight research program.

APPENDIX A

SPARE PARTS

CONTRACT N62269-77-C-0035

Part Number	Balance On Hand	Part Number	Balance On Hand	Part Number	Balance On Hand
AN103816	49	MS9241-022	12	583154	1
AN103909	1	MS9241-041	1	583604	24
AN320-4	10	MS9241-110	1489	583736-2	5
AN924-4C	2	MS9241-112	1492	583736-3	17
AN960-10L	3	MS9241-114	6	583736-8	17
MS19070-003	11	MS9241-115	4	582003-2	12
MS20364-1032	13	MS9241-117	1196	592022	4
MS20364-1032A	2	MS9241-121	2	592051	1
MS20426D3-4	32	MS9241-123	696	592069	6
MS21043-4	18	MS9241-127	2	SK94932	2
MS21045-08	24	MS9241-137	288	592078	9
MS21902-4C	28	MS9241-159	8	592080	7
MS21912-4C	2	MS9241-160	2	592111-1	10
MS21921-4C	25	MS9241-213	696	592116	205
MS21922-4	24	MS9241-246	121	592123-1	6
MS24678-25	99	MS9241-259	92	592123-2	4
MS28774-026	2	MS9241-280	8	592123-3	3
MS28775-010	4	MS9245-21	27	592123-4	3
MS28775-011	2	MS9245-25	2	592131-3-10	1
MS28775-014	8	MS9245-28	32	592141	88
MS28775-016	16	NAS1193-6C	8	592143	7
MS28775-017	8	NAS1291X3	197	592203	2
MS28775-018	2	NAS1291X5	83	592250-4	2
MS28775-025	2	NAS428-4-5	1	592301-1	37
MS28775-026	2	NAS620-416	2	69306-10	86
MS28775-119	3	553888	2	69306-16	42
MS28775-124	12	580384-1	16	69429A123	74
MS28775-135	12	582313-220-G2	8	69429A135	72
MS28775-331	4	582400A11	35	69429A6	234
MS9015-04	2	582400A14	6	69445A3	2
MS9241-08	3	582400A5	5	69490C426	13
MS9241-010	4	582400A6	48	69490D43	15
MS9241-011	1528	582551	2	69494B24	2
MS9241-012	1531	582555-2	5	69494C152	1
MS9241-014	1364	582555-5	4	69494C154	13
MS9241-016	1326	582605	4	69494C252	8

SPARE PARTS

CONTRACT N62269-77-C-0035 (Continued)

Part Number	Balance On Hand
69494D231	12
69494D32	8
69494D33	8
69494D6	81
69494D904	30
69494J904	6
69804-5A	26
69863-31	137
69915-4	18
69915-6	4
719955-3	21
720752-26	54
720799-3	1

SPARE PARTS

CONTRACT N00019-75-C-9005

Part Number	Balance On Hand	Part Number	Balance On Hand	Part Number	Balance On Hand
MS24665-149	167	592098	2	592175	1
MS28774-017	32	592104	1	592177	1
MS28774-119	37	592105	1	592178	1
NAS1193-6C	3	592108-2	1	592202	1
SK56009	4	592115	8	592205	1
SK56060	1	592117-2-1	8	592209	2
SK56098	1	592118-2	2	592211	3
554629	1	592120-	2	592212	3
584159	28	592121	1	592213	2
592003-1	203	592122-1	1	592301-1	19
592003-2	35	592123-1	4	592301-2	22
592004-1	11	592123-10	19	592306	1
592004-2	23	592123-12	3	592310	3
592004-6	99	592123-13	3	592314	7
592005	1	592123-2	3	592314-2	2
592011	3	592123-3	11	592323	1
592012	3	592123-4	33	592324	8
592020	1	592123-7	3	592332	1
592021	1	592123-8	54	592333-1	2
592024	7	592126	4	592335	6
592035-1	2	592131-3-10	77	592359-1	50
592036	3	592131-4-10	77	592359-2	1
592037	1	592131-4-12	98	592361-1	1
592042	1	592131-4-13	92	592361-2	1
592051	1	592131-4-28	92	592362-1	2
592052	3	592131-4-32	96	592362-2	2
592057-2	6	592131-5-16	16	592369	4
592058	1	592131-5-19	47	592371	3
592064	14	592137	3	592379	3
592065	7	592138	2	592383	1
592070	2	592143	11	592389	6
592071	1	592145	5	592394	1
592073	1	592155-1	1	592395	1
592078	15	592156	2	592399	4
592084-2	4	592159-1	2	592400-4	1
592084-3	1	592160	2	592406	2
SK54037	1	592172-1	1	592409	2

SPARE PARTS

CONTRACT N00019-75-C-9005 (Continued)

Part Number	Balance On Hand
592410	5
592413	1
592425	2
592498	12
720771-20	1
720790-1	7
720790-2	8
133X-21	110
1FA7A40A	2

APPENDIX B

OPERATING AND MAINTENANCE INSTRUCTIONS
X-22A PROPELLER SYSTEM

November 10, 1964

Revision #1 - November 19, 1964

Revision #2 - March 18, 1965

Revision #3 - July 21, 1978

November 10, 1964

OPERATING AND MAINTENANCE INSTRUCTIONS X-22A PROPELLER SYSTEM

1.0 Introduction & Description

1.0.1 Introduction

1.0.2 This manual is issued to furnish basic operation and maintenance instructions for the X-22A VTOL Research Aircraft Integral Gearbox Aircraft Propeller System. The system is manufactured by Hamilton Standard, Division of United Aircraft Corporation, Windsor Locks, Connecticut.

1.1 General Description

1.1.1 The X-22A propeller system consists of the following assemblies:

a. Two integral gearbox propeller assemblies designated as model 131GB8-1.

b. Two integral gearbox propeller assemblies designated as model 131GB9-2.

c. One propeller Master Control assembly designated as part number 585623.

1.1.2 The propeller model numbers 131GB8-1 or 131GB9-2 indicate the following:

a. The first number, 1, indicates the propeller hub type.

b. The second number, 3, indicates the number of blades.

c. The third number, 1, indicates the Hamilton Standard blade shank size.

d. The letters, GB, indicates an integral gearbox type propeller assembly.

e. The fourth number, 8 or 9, indicates the type of gearbox.

1.1.2 (Cont.) f. The dash numbers, -1 or -2, indicate the direction of propeller rotation and future modification. Odd dash numbers indicate right hand rotation; even numbers, left hand rotation.

In Hamilton Standard practice, the propeller model number is the propeller part number and is identical to the propeller assembly drawing number. Changes in design, therefore, affecting interchangeability of the integral gearbox propeller assembly are identified by a change to the dash number. The odd-even significance of the dash number, however, remains constant.

1.1.3 The Master Control part number, 585623, is a non-significant designation. Changes in design affecting interchangeability of the Master Control assembly are identified by a change to the part number.

1.1.4 Parts List Number

1.1.4.1 A rigid parts list numbering system is used by Hamilton Standard to distinguish various detail configurations of the basic assembly. Because the X-22A is a research aircraft, assemblies identified by the same part number, as delivered, may differ in detail. Such differences may be the result of the presence or absence of particular instrumentation, presence of parts modified to accommodate instrumentation or any one of many valid reasons. Each specific configuration, however, is identified by a specific parts list number and hence any changes to a delivered assembly must be recorded on the historical record card furnished with the assembly so that continuity is maintained.

1.2 Special Tools

1.2.1 No special tools are required for installation of the integral gearbox propeller assembly or the Master Control.

1.2.2 For physically checking blade angle, an NASA Universal Type Protractor and blade template may be used. A blade template will be furnished by HSD.

1.2.2 (Cont.)

TABLE I

Material Reference

Material	Specification
Hydraulic Oil	MIL-H-5606
Lubricating Oil	MIL-L-7808 (Note 1)
Hydraulic Oil, Preservative	MIL-H-6083 Type 1
Trichlorethylene, Inhibited	MIL-T-7003

Note 1: Recommended oil is "Cellutherm" manufactured by Celanese Chemical Co., 180 Madison Ave., New York 16, New York procured to Specification MIL-E-7808 Revision 5.

2.0 Installation

2.1 Gearbox Propeller Assemblies

2.1.1 The integral gearbox propeller assembly is delivered fully assembled except for the spinner, afterbody, and their attaching hardware. To facilitate installation, the propeller is shipped in a special container designed to accommodate the assembly in a nose-down attitude.

2.1.2 An internal bracing structure supports the propeller in the container. When the slotted angle framework which constitutes the sides and top of the container is removed, the bracing structure will support the propeller assembly by the gearbox 45° strut mounting pads.

2.1.3 Since installation of the propeller in the BAC test duct will vary from the installation in the aircraft duct, this instruction will not endeavor to cover handling procedures. It is assumed that BAC will be able to lift and position the assembly in a manner suitable for the particular installation. HSD furnished oil temperature sensing bulb, *56B17R, for use in test may be installed in place of the oil drain plug either prior to or after installation of the assembly in the duct (see 2.5g). BAC furnished instrumentation such as the propeller gearbox oil temperature switch, oil

* Designation of modified MS28034-3 temperature bulb manufactured by Lewis Engineering Company, Naugatuck, Connecticut.

2.1.3 (Cont.) pressure transducer or other items also may be installed in the assembly either prior to or after installation of the assembly in the duct. (See 2.5 (g) and (h)). For greatest ease of installation, it is recommended that units on the rear face of the gearbox be installed prior to assembly of the gearbox and aft centerbody.

Caution: In no case is it permissible or advisable to lift or position the propeller from any part of the blades.

2.1.4 Install the propeller in the duct using the fasteners and observing the torque requirements shown on HSD drawing L-8856-21-1 a copy of which is included as Appendix A to these instructions. (Ref. BAC drawing 2127-440002).

2.1.5 Make the following connections between the particular installation and the propeller.

a. Drive shaft to propeller input pinion. (No impact load should be used to make this connection.)

b. Beta Control input shaft to propeller signal converter (See rigging procedure 2.9).

c. Hydraulic supply lines (2) to propeller servo control valve.

d. Hydraulic return lines (2) to tee connections at rear of propeller transfer bearing.

Caution: Interchange of hydraulic supply and return lines will result in damage to the propeller transfer bearing.

e. Overboard drain to fitting at rear of propeller transfer bearing.

f. Electrical connections (2) to propeller gearbox horizontal and vertical chip detectors.

g. Electrical connections (2) to propeller gearbox sump thermocouple (HSD furnished) installed in the oil drain plug and temperature switch (BAC furnished).

h. Connection to propeller gearbox lube pressure transducer (BAC furnished).

i. Any instrumentation required such as feedback rod potentiometer, vibration pickups, transfer bearing thermocouples, etc.

2.1.6 Pitch Change Actuator Bleeding Procedure

2.1.6.1 With the propeller in the VTOL position and the hydraulic supply and return lines connected, apply 250-3000 psi hydraulic pressure to both propeller systems and maintain this pressure. Insert a piece of transparent plastic tubing over one of the four bleed screw nipples and crack open the bleed screw. With the bleed screw open, cycle the blade angle between full low and high pitch until no air shows in the oil flowing through the plastic tube. Close the bleed screw, torque to 15-20 inch pounds and remove the plastic tube.

2.1.6.2 Repeat 2.7 with each of the other three bleed screws. Lockwire the bleed screws to each other.

Note: Failure to remove all of the air from the pitch change system may affect the stability of the propeller control.

2.1.7 Gearbox Oil Filling Procedure

2.1.7.1 With the propeller in VTOL position remove the gearbox oil filler plug in the nose of the gearbox. Add four (4) quarts of MIL-L-7808 oil through the filler hole. Reinstall the plug, torque and lockwire.

Note: More than five quarts of oil may cause explusion of oil through the breather during operation. Less than four quarts of oil may result in inadequate lube pressure.

After filling the gearbox statically or prior to operation after a long shutdown, there may be very little, if any, oil visible in the sight glass. During operation the proper oil level may only partially cover the sight glass with the propeller in either vertical or horizontal position. Immediately after shutdown, however, the sight glass should be covered with the propeller in either position.

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DISASSEMBLY INSPECTION AND OVERHAUL OF X-22A GEAR REDUCTION AND--ETC(U)
JUL 78 E H WALZ N62269-77-C-0035

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2.1.8 Barrel Oil Filling Procedure

2.1.8.1 With the propeller in VTOL position, remove the two propeller oil filler plugs in the propeller dome cap. Add two (2) quarts of MIL-H-5606 hydraulic oil to the barrel cavity through either one of the fill holes. (The other hole acts as an air bleed.) Reinstall the plugs, torque and lockwire.

Note: More than two quarts of oil will cause loss of oil through the overboard drain as a result of expansion during operation. Much less than two quarts of oil may cause uneven distribution during operation and result in propeller unbalance.

2.1.9 Beta Control Rigging

2.1.9.1 Set the aircraft linkage to the propeller signal converter at the equivalent of 17.4° blade angle (at 36 inch station on the blade face marked with the yellow index mark). Turn on at least 500 psi supply pressure to one hydraulic system. Turn propeller signal converter input shaft until blade angle reads 17.4 ± .1° measured at the 36 inch station. Note or mark position of input flange.

Caution: Do not turn propeller signal converter input flange or blades without at least 500 psi on one hydraulic supply system or serious damage may result to the control linkage. Make sure return lines are not capped.

2.1.9.2 The aircraft linkage may then be connected to the propeller signal converter input flange. Before making the connection check position of input flange.

2.1.10 Dome Cap Torquing Procedure

2.1.10.1 If any of the twelve (12) dome cap holdown screws has been removed (i.e., for installation of a lifting aid) they shall be retorqued as follows:

a. Number the screws clockwise or counterclockwise 1 through 12. The location of bolt No. 1 is arbitrary.

b. Torque all screws to 110-120 in-lb. The torque sequence is 1, 7, 2, 6, 12, 8, 3, 5, 11, 9, 4, and 10.

c. Retorque all screws to 140-150 in-lb in the same sequence in (b). Lockwire the screws.

Note: Threads and thrust face of the screws should be lubricated with petrolated graphite MIL-T-5544 before torquing.

2.1.11 Spinner and Afterbody Installation

2.1.11.1 Run the blades to full low pitch prior to installation of the spinner.

Caution: Failure to run the blades to full low pitch prior to installation of the spinner or changing the blade angle during installation of the spinner may result in severe damage to the blade fairing or spinner.

Install the spinner being careful to match the index mark on the spinner with the mark on the spinner bulkhead. Install the seven (7) special spinner retaining washers and self-locking nuts. Torque as indicated on bulkhead.

2.1.11.2 Install the afterbody shells with lips forward. Install the fourteen (14) afterbody attaching screws and washers. Torque as indicated on the shell.

2.2 Master Control

2.2.1 The Master Control is delivered fully assembled except for the clutch assembly mounting bolts which are supplied as part of the BAC attaching hardware.

2.2.2 Install the Control on the drive pad. Torque the retaining nuts to 100 in-lbs minimum. Connect the solenoid lines, pressure lines, and the hydraulic lines to the heat exchanger. Refer to HSD Installation drawing SK54040 for identification of Primary and Secondary system connections.

Caution: Lines from fittings 1 and 2 must be paired and go to one heat exchanger. Lines from fittings 3 and 4 must be paired

2.2.2 (Cont.) and go to the other heat exchanger. Failure to do so could result in severe damage to the Master Control.

2.2.3 Beta Linkage Rigging

2.2.2.1 The Master Control actuator output shaft and aircraft beta shaft shall be aligned and connected according to the following procedure. Section 2.1.9 must be accomplished prior to this section.

a. With a minimum of 500 psi supply pressure to all four propeller blade actuators, rotate the beta linkage by hand until the blade angle of the four propellers reads +45.4° at the 36" station.

b. Remove dust cover on the end of the Low Pitch Stop assembly and insert a screw driver in the slot provided in the shaft of the low pitch stop and rotate the shaft clockwise until the high pitch stop is contacted.

c. Connect the beta shaft and the actuator output.

2.2.4 Speed Set Lever Rigging

2.2.4.1 Position the Master Control Speed Set Input Lever at Take-off (100% RPM) and install the rigging pin. Correspondingly position the cockpit or console control. Adjust the linkage to the Master Control and make the connection. Remove the rigging pin and adjust the console or cockpit lever stops so as to obtain the following travel of the input lever on the Master Control:

Clockwise (overspeed reset)	20° ± 1°
Counterclockwise (min. speed)	90° ± 1°

Caution: Operation of the speed set lever beyond the above range limits may result in damage to the internal Master Control linkage. Less travel will result in less speed range adjustment available to the operator.

2.2.5 Master Control Filling

2.2.5.1 The Master Control has two oil sumps, a "Primary" sump and a "Secondary" sump. A dry control will be properly filled when 32 fluid ounces of MIL-H-6083 hydraulic oil is added to each sump. The sump

2.2.5.1 (Cont.) filler holes are located on each side of the secondary solenoid (Ref. HSD SK54040). The hole nearest the control mounting flange fills the "Secondary" sump and the hole nearest the speed set lever fills the "Primary Sump".

Note: More than 32 ounces in each sump may cause loss of oil out the breather and reduction in performance. An inadequate quantity of oil will cause a reduction in performance.

When the control is properly filled, the oil level will be over the sight glasses.

3.0 Operation of Propeller System

3.1 Inspection

3.1.1 Perform the preoperation or daily inspection if not previously accomplished. Prior to start-up both hydraulic supply systems to the propeller control should be set for 3000 psi.

3.2 Start-up

3.2.1 Set Master Control to govern at 2590 PRPM. On start-up set speed at 1810 PRPM with the power lever. This will be a non-governing condition. Check readings of all instrumentation. Propeller gearbox lube pressure should be approximately 15-20 psi. Master Control pressures should be 800 - 1600 psi.

3.3 Idle

3.3.1 It is recommended that idle speeds between 1000 and 1700 propeller RPM be avoided because of a gear resonance at approximately 1335 PRPM. Advance to idle RPM without lingering in the above range.

3.4 Operation

3.4.1 Observe the following criteria during all propeller operation.

1. Propeller RPM

2. Gearbox Lube Oil Pressure. This will vary from approximately 10 psi at low speed and high temperature to approximately 60 psi at high speed and low temperature.

3.4.1 (Cont.)

3. Gearbox Sump Oil Temperature (Recommended maximum 250°F)

4. Propeller-Gearbox Vibration. The recommended maximum level is 10 mils in any direction with occasional transients to 30 mils considered acceptable.

5. Propeller Gearbox Input Torque. Observation of engine output torque and/or propeller blade angle and RPM should be made to insure operation within the design limits of Table I in BAC Report 2127-947003. (The 1950 hp condition should not be continuously longer than 10 seconds duration.)

6. Propeller Control Supply Pressure. Supply pressure should not be less than 2640 psi to each system at zero pitch change rate.

7. Chip Indicators. If a chip is indicated, remove appropriate unit and examine chip. Continue operation unless repeated chip indications show deterioration is taking place.

3.4.2 Governing Check - After start-up and initial reading, advance power levers until propeller system is governing at 2590 PRPM. Both Master Control pump pressures should be 600-900 psi.

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3.4.3 Overspeed Governor Check - After performing governing check per paragraph 3.4.2 and with engine power approximately 600 hp, move the Master Control speed set lever to the overspeed reset position. Propeller speed should increase to 2700-2800 PRPM. Operation on the overspeed governor may be less stable than when operating on the normal speed governor.

3.4.4 System Switchover and Dump Valve Check - With the propeller governing at 2590 PRPM and at approximately 600 hp, the Master Control Primary System Dump Valve will be actuated. A reduction in propeller speed to a minimum of 2500 PRPM is allowable. Primary system pump pressure shall drop a minimum of 100 psi. When the dump valve is deactuated, speed and pressure shall return to their original conditions. This check will be repeated with the Secondary System dumped, and secondary pump pressure shall drop a minimum of 100 psi with an allowable speed reduction to 2500 PRPM. Deactuation of the Secondary Dump Valve shall return speed and pressure to their original conditions.

3.4.5 Low Pitch Stop Operation - The recommended procedure for retracting the Master Control Low Pitch Stop when ground idle operation is desired is as follows:

1. With the system running at scheduled RPM, reduce power until the flight idle stop is reached. This will be indicated by RPM dropping below the set value.

2. Increase power just enough to return to scheduled RPM.

3. Actuate the solenoid which dumps the secondary system of the Master Control and retracts the Low Pitch Stop.

4. Reduce power to the ground idle level.

5. Deactuate dump solenoid.

Note: For any decrease of pitch below flight idle, repeat steps 3, 4, and 5.

The recommended procedure for returning to flight idle or higher powers from ground idle is as follows:

1. Increase power as slowly as possible to a value slightly above flight idle. Governing should be indicated at this point by RPM holding at the scheduled value.

2. Reduce power until the flight idle stop is reached. This will be indicated by RPM dropping below the scheduled value. The purpose of this operation is to check that the Low Pitch Stop has returned to the flight idle position.

3. Adjust power and RPM settings for the desired operating condition.

Caution: When operating below the flight idle stop, do not make sudden large increases in engine power. Severe overspeeds of the propeller and engine could occur.

4.0 Maintenance

4.0.1 This section contains instructions for the maintenance of the propeller system which can be performed in the field. This maintenance is limited to servicing, adjustments, minor replacements and minor repairs which do not require specialized assembly tools or shop test equipment.

4.1 Gearbox and Propeller

4.1.1 Disassembly

4.1.1.1 For normal field servicing, it is only necessary to remove the spinner afterbody and nose section. For 50 hour inspections access to the back of the gearbox is required. To remove the afterbody, remove the fourteen attaching screws (Ref. P/N NAS 428-4-5)). (If one of the screws is located behind a propeller blade rotate the propeller by hand until the blade clears the fastener.) The afterbody is made up of two 180° segments which can be unfastened, rotated to any desired position and removed in a radial direction. To remove the spinner nose section remove the seven attaching locknuts and washers. Until these instructions are revised no other disassembly shall be performed except by the manufacturer's representatives.

4.1.2 Preoperation or Daily Inspection

4.1.2.1 Gearbox Oil Level Check

4.1.2.1.1 Immediately after shutdown in the VTOL position, the oil level should be at or above the top of the sight glass. If level is between center and top of glass add 1 pint. If level is below center of glass, add 1 quart and run propeller up to idle RPM and shutdown for recheck.

4.1.2.2 Master Control Oil Level Check

4.1.2.2.1 Immediately after shutdown, the oil level of both systems of the Master Control should be above the sight glasses. If the level is midway on the sight glass, add 18 oz. of MIL-H-6083 Type 1 to that system. If the oil level is below the sight glass, drain the system and refill per paragraph 2.2.5.

4.1.3 Physical Condition Check

4.1.3.1 After 5 hours of operation or daily check the following:

1. Examine blades and spinner for damage.
2. Check that blade backlash is no more than 0.15 deg.
3. Check that all mounting connections are secure.
4. Examine for leakage. Slight seepage at rotating seals is to be expected.
5. Check for looseness in propeller control linkage.
6. Examine gearbox housing for signs of chafing by strut fairings. Remove interferences if necessary.

4.1.4 25 Hour Inspection

4.1.4.1 Remove the spinner afterbody and nose section and examine all parts of the propeller for damage. Inspect spinner Rosan inserts for tightness.

4.1.4.2 With the duct in horizontal flight attitude, and the spinner removed, rotate the propeller until the two filler plugs on the dome cap are in a vertical plane. Remove the top filler plug and determine the fluid level relative to the bottom of the top plug hole. Two quarts should bring the fluid level to the bottom of the top hole. If the level is below this point, rotate the propeller clockwise until the top filling hole is at the three o'clock position or until the fluid drains out of the hole. If the fluid flows out of the hole before it reaches the three o' clock position, no additional fluid need be added. Otherwise add MIL-H-5606 fluid until the level reaches the bottom of the top filler plug hole when this hole is at the twelve o'clock position.

4.1.5 50 Hour Inspection

4.1.5.1 Repeat the procedures given in all previous inspection and also perform the following additional tasks.

a. Remove the gearbox chip detectors (2) and clean with MIL-T-7003 trichlorethyline. Reinstall, torque and lockwire the chip detectors.

4.1.5.1 (Cont.)

b. With the propeller in VTOL position, drain propeller gearbox oil by removing the oil filler plug and the oil drain plug. Reinstall the drain plug, torque, lockwire and replenish the gearbox with 4 quarts of MIL-E-7808 oil. Reinstall the oil filler plug, torque and lockwire.

c. Drain both systems of the Master Control by removing the magnetic drain plug in each system. Remove and clean both filters. Reinstall the drain plugs and filters and refill per paragraph 2.2.5.

4.1.6 250 Hour Inspection

4.1.6.1 Remove the propeller system and return to the manufacturer for overhaul. Under the present concept major repairs or overhauls must be performed at the factory. Necessary special assembly tools and test equipment are not available in the field.

4.1.6.2 Preservation, packing and packaging of the propeller should be in accordance with MIL-P-6074, Level One.